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Bridge Over Missouri River at Weldon Springs, Sept. 15, 1936 *View Down Stream.*

THE SAINT LOUIS EXPRESS HIGHWAY

Looking Easterly toward Kingshighway Boulevard Overhead, Sept. 14, 1936.

A Review of the Main Features of a Forty-One Mile Project to Secure an Efficient City Entrance

By JOHN C. BLACK

Field Editor, Roads and Streets

AMONG the improvement now in progress to effect better connections between rural main highways and the central districts of our cities, one of the most important, as well as most interesting, is the "Express Highway" into and through the City of St. Louis. When completed, it will serve not only the primary purposes of entrance and exit, but it will provide a fast and safe cross-town connection. The project has a total length of approximately 41.5 miles, 34.7 miles being without and 6.8 within the city limits. Two important units in the 41.5-mile route lie on developed thoroughfares involving no current improvements.

Missouri River Bridge, Sept. 15, 1936.
Photo by the Author.

Major Divisions of the Project

Beginning at the junction of U. S. Routes 40 and 61 at Wentzville, which may, for convenience, be termed the westerly end, the project falls into natural divisions as follows:

Wentzville to the Missouri River—an entirely new highway location involving grading, paving and two small bridges	13.3 mi.
Bridge over Missouri River	0.5
Missouri River to Bellefontaine—a new road, chiefly on new location, involving grading, paving and minor structures	6.5
Bellefontaine to Lindbergh Blvd.—a scenic highway having two 20-ft. pavements, separated by a 30-ft. parkway, chiefly on new location, involving grading, paving, minor structures, and landscaping	8.4
Lindbergh Blvd. to City Limits. This portion of the Express Highway is located on Clayton Road, a 6-lane thoroughfare. No changes are being made at this time	6.0
City limits to the beginning of new construction in Forest Park—On city streets, a park drive, and temporary connection	0.3
Beginning of new construction in Forest Park to Hawk Avenue—a 5-lane pavement on new right of way with no street intersections at grade	3.0
Hawk Ave. to Municipal Bridge over the Mississippi. A new overhead structure is to be built in the near future from a point even with Hawk Ave. across Vandeventer Ave. to the present Chouteau Ave. viaduct. When it is completed traffic will be routed down Chouteau Ave. (a wide thoroughfare) to the Municipal Bridge	3.5
Total	41.5 mi.

For construction purposes, the work has been divided into a considerable number of separate projects. The total cost, exclusive of the Clayton Road and Chouteau Ave. sections is estimated at $5,632,696, divided as follows:

2.96 miles construction in the City of St. Louis	$1,742,376
Missouri River Bridge	1,221,671
Rural highway construction	2,668,649

Right-of-way and engineering costs not included.

General Considerations and Characteristics

An economic analysis is beyond the scope of this article, but the reason for the development may be stated briefly as the provision of a practical connection between the heart of St. Louis and main highways to the West and North, as well as connection through the city for tourist and other traffic. This city, while better than many as respects broad radial thoroughfares, is still not easy to get into and out of. The older routes within the city limits are all at grade with the handicap of unlimited local traffic and great numbers of street crossings and intersections. The 2.96 miles of new route now nearing completion, has on the other hand, not a single grade crossing throughout its length, and is connected with cross streets by ramps at only two points.

Outside the city the Express Highway is characterized by modern location, with grades and curves designed for high speed traffic. It eliminates the narrow and inadequate St. Charles bridge, as well as the awkward and somewhat congested route through the City of St. Charles.

The distance from Wentzville to the business center of St. Louis will be shortened 7 mi. by the new route; but this, of course, is of less importance than the increased efficiency due to wider pavement, improved grades and alignment and the avoidance of congested traffic and grade crossings. When completed, the highway will become a part of U. S. Route 40. In fact, it is already generally referred to as "New 40."

The project has been financed in part under the National Recovery Act. The Missouri State Highway Department lets all contracts and supervises all construction. The work was undertaken and largely carried out under the direction of T. H. Cutler, Chief Engineer of the Department until his resignation in August to accept the chief engineership of another state. C. W. Brown, who succeeds Mr. Cutler as chief engineer in Missouri is now in charge.

Wentzville to Missouri River

The 13.3 miles from Wentzville to the Missouri River is on an entirely new location. Right of way is 100 ft., all of it having been secured by the State Highway Department.

Grading is complete, and paving well started, about 3 mi. of 21 ft. slab having been laid up to September 15.

The completed pavement will be 32 ft. wide (only 21 ft. now under contract) with a lip type concrete section, reinforced with 42 lb. of mesh per 100 sq. ft. The mix is 1 : 2 : 3½ and is carefully proportioned by weight. Concrete is poured on tar paper spread on the subgrade with a lap of 4 in. between strips. Shoulders will be 8 ft. The maximum grade is 7 per cent and the sharpest curve 4°.

The Regenhardt Construction Co. of Cape Girardeau, Mo., is the paving contractor. They have a large and complete outfit including two 27 E pavers, and work two 6-hour shifts, electric light from a portable plant being used as needed. Their crew numbers about 70 men to each shift. I regretted being unable to get pictures of this hustling job, but arrival just at dusk made photography impossible. About 1800 ft. of 21 ft. slab is being laid per day when weather does not interrupt—an average of 900 ft. per shift.

The drainage structures on this section, including several small steel and concrete bridges, are complete. The grading, some of which has been completed for a considerable time, has washed in places until conspicuous gullies have developed, but the quantity of material so eroded is not important.

Estimated cost of this section is $562,836, with major items as follows:

Grading (Earth Exc. 16c, Rock Exc., 60c per cu. yd.)	$145,506
Paving ($1.93 per sq. yd.)	339,038
Bridges	78,262

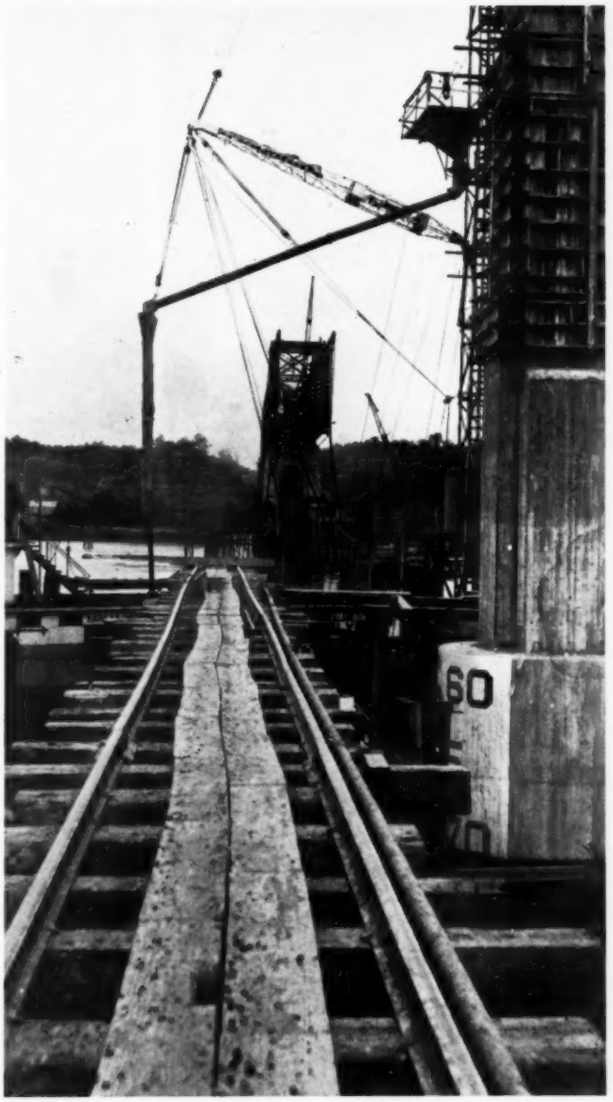
Missouri River Bridge

The bridge over the Missouri River at Weldon Springs consists of two 1025 ft. main spans, continuous over the center pier, a 145-ft. approach span at the north end, one 145-ft. and two 130 ft. approach spans at the south end—a total of 2600 ft. The bridge carries no sidewalk. The clear deck width is 32 ft., and there is a 1 ft. welded steel curb on each side. Truss depth is 74 ft. 11 in. over the center pier; and 57 ft. throughout the major portion of the main spans. The bridge at St. Charles, which at present carries U. S. Routes 40 and 61, has a clear width of only 16 ft. and is a serious handicap to traffic. Superstructure erection on the new bridge was begun at the north end, and has now progressed to a point midway in the southerly main span. The structure is scheduled for completion and opening February 22, 1937.

The north abutment and the three piers supporting the main spans rest on solid rock, while the piers and abutment supporting the south side approach are carried on steel piles about 90 ft. long. Compressed air caissons were used on all the river piers, the maximum depth below water level being 90 ft. Two caissons were sunk 36 ft. 9 in. apart center to center for each pier, and a concrete web constructed between them. Caisson diameter is 22 ft. The connecting web is 7 ft. 6 in. thick. The upper part of each pier is finished in pleasing modernistic design.

The first caisson for the south pier of the 130 ft. span is shown in the picture. This was taken on September 15 at which time it was expected that air would be applied within another day or two. Due to low water in the river this pier was started on dry ground.

A floating concrete plant, which can be moved from place to place as needed, has been used on all pier construction. Low water in the river which has been of so much advantage in some ways, is a handicap here; and in the case of the southerly pier and abutment has required the construction of a trestle and narrow gauge track from shore to the second pier—the nearest point at which the plant could be moored. The outfit is equipped with a one cu. yd. mixer and produces from 30 to 35 yards of 1:2:4 concrete (weight proportion) per hour. All concrete materials are delivered by water. Kansas City Bridge Co. is the contractor. Contract prices are as follows:



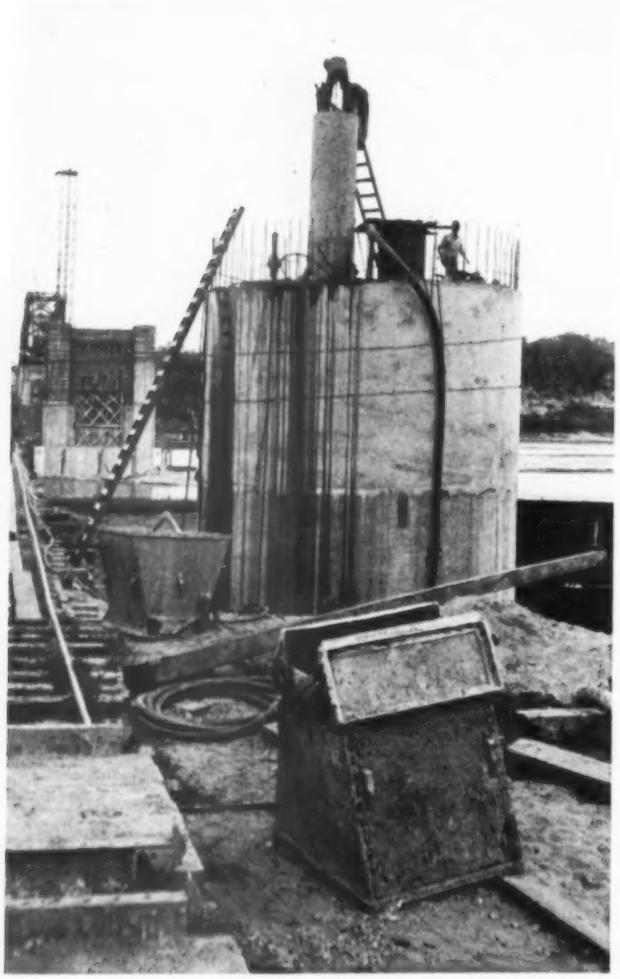
Missouri River Bridge, Sept. 15, 1936, Showing Concrete-Handling Track on Trestle, Boom and Spout of Floating Concrete Plant, Bridge Structure in Background.
Photo by the Author.

Class "B" Concrete	$20.00	per cu. yd.
Earth Excavation	0.50	per cu. yd.
Structural Steel	0.072	per lb.
Steel Piles	2.00	per lin. ft.

Total contract, $1,221,671.

Missouri River to Bellefontaine

South of the river the pavement has been completed to Bellefontaine—a distance of 6½ miles. This is a 30 and 40 ft. slab with 8 ft. shoulders, on a 100 ft. right of way. Shoulder trimming and adjustment were still in progress near the bridge on September 15.



First Caisson of South Pier, Sept. 15, 1936. *In background, the next pier with upper forms still in place, the mast of floating concrete plant, and the advancing superstructure of the bridge.*
Photo by the Author.

Among the conspicuous features of this section are the vertical cuts in the loess soil. Only two types of back slope can be used in this formation—the vertical type and a very flat slope with a sodded surface. Both types involve difficulties, but the vertical is considered generally preferable. Its chief fault is that it sloughs off in vertical planes during the rainy season and also during periods of freezing and thawing. The accompanying picture shows the bench which has been constructed at the toe of the slope to catch this sloughed material and permit of its removal before it clogs the drainage ditch. With cuts of this character it is also necessary to provide gutters at the top to intercept side hill drainage, as water flowing over the edge of the vertical bank quickly destroys it. On this project about 3000 ft. of half section corrugated metal pipe has been placed at the top of the back slope near the right-of-way for this purpose. The curves are all of large radius. Six per cent is the maximum grade. Grading on this section was done by M. E. Gillioz and the pavement was laid by Marie Construction Co. The cost was $505,813.

Earth Excavation	$ 0.20 per cu. yd.
Class "B" Concrete.....	20.00 per cu. yd.
P.C.C. Pavement	2.10 per sq. yd.

Bellefontaine to Lindbergh Boulevard

Continuing for another 8.4 miles from Bellefontaine toward St. Louis, the highway will consist of two 20 ft. lanes of concrete pavement separated by a 30 ft. parkway. There are 8 ft. shoulders on the outside. Back slopes will be very flat, and the entire section will be featured by careful landscaping. Right of way width for this section is 200 ft. Six grade separations will reduce the menace and interference of cross traffic to a minimum. Contracts for this section are to be let in the near future. The estimated cost is $1,600,000.

Lindbergh Boulevard to Forest Park

The remaining section of the Express Highway to the corporate limits of St. Louis—a distance of 6.0 miles—will lie on Clayton Road. This is for the most part a 6-lane thoroughfare, and for the present will serve adequately as a link in the Express Highway. It is noteworthy, however, that the state highway engineers have already given tentative consideration to paralleling it with an entirely new line at a distance of 600 or 700 ft. Clayton Road carries a very heavy traffic at the present time.

Between the city limits and the beginning of the new pavement in Forest Park—a distance of approximately 0.3 mile—the route crosses a wide space formed by the intersection of Clayton Ave., Skinker Blvd., and several minor streets. It is proposed ultimately to put the Express Highway in an underpass at this point, but the construction expense will be heavy, and no definite date has as yet been set for it. The possibility of a new highway parallel to Clayton Road is a further reason for delaying action on this connection. The present crossing at grade, while not ideal, is entirely practical with adequate policing of the intersection.

View on the Express Highway a Few Miles South of Missouri River Bridge, Showing Vertical Cut in Loess Formation

Photo by the Author.

From the Beginning of New Construction in Forest Park to Hawk Avenue

The location of current construction inside the city limits may be best understood by reference to the accompanying map. Undoubtedly the most noteworthy feature is the complete absence of grade intersections.

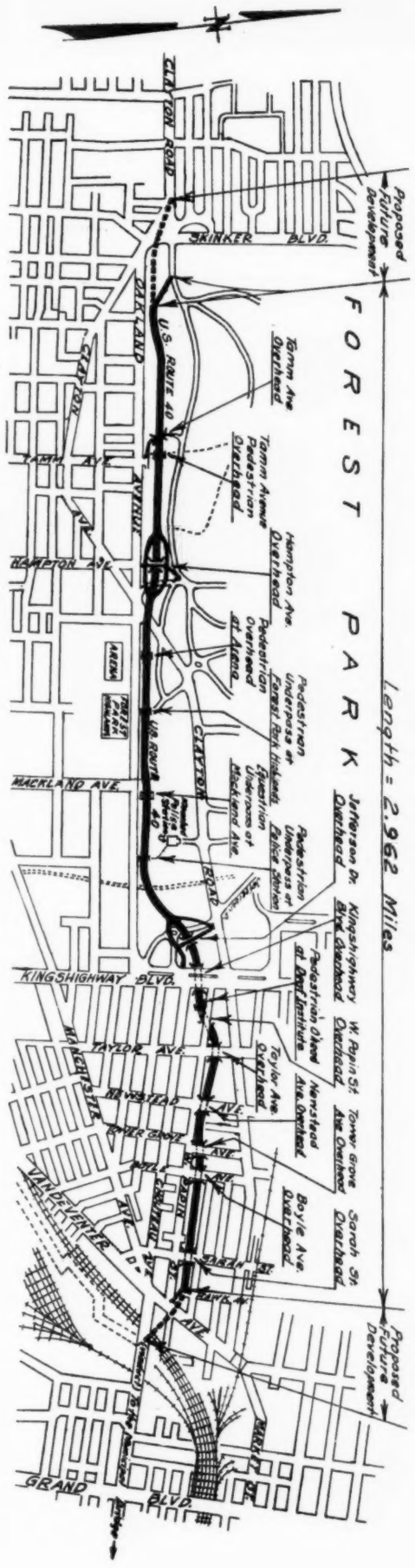
Pavement Design. The Express Highway pavement in St. Louis has a width of 50 ft. throughout except

Tamm Ave. Pedestrian Overhead.
Photo by Courtesy of Missouri State Highway Department.

for short widenings at connecting points. The slab has a thickness of 10 in. at the edge and 8 in. at center, and is reinforced with 42 lb. of mesh per 100 sq. ft. The center 10-ft. lane is marked with white cement strips, 8 in. wide, inlaid 1 in. deep in the pavement surface. The 9 in. lip curb at the edges is also of white cement. Pavement concrete is a 1:2:3½ mix, weight proportioned. The maximum grade is 4 per cent, and the sharpest curve 7°.

Naturalistic Rock Work Along the Express Highway through Forest Park.
Photo by Courtesy of Missouri State Highway Department.

Forest Park Location. The location through Forest Park is a wise one, reflecting credit on both the engineers who planned and the park authorities who permitted it. The well known jealousy of such bodies against encroachments on the lands under their jurisdiction has a sound basis, and should be relaxed only in highly exceptional cases. The Express Highway afforded such an instance: Any other route would have involved not only a large increase in right-of-way cost but a dozen or more street intersections which would



Location of Express Highway Construction in the City of St. Louis. The westerly city limit is at the end of the proposed future development indicated by arrow at Clayton Road.

The Tamm Ave. Highway and Pedestrian Overheads.

Photo by Courtesy of Missouri State Highway Department.

have had to remain at grade or be passed at an enormous expense for separations. The right-of-way granted is so close to the park border as to be of minimum detriment. Crossing it are three highway overheads, two pedestrian overheads, two pedestrian under-passes, and one equestrian under-pass.

Complete "clover leaf" connections are provided at the Hampton Avenue intersection, about midway in the park length, and a modified clover leaf at the Jefferson Drive intersection near the east end.

Construction of Park Section. Construction through the park was begun in 1934 and is now complete except for some sodding of slopes and minor landscape work not included in the main contracts. Most of the route lies in sidehill cut, the slope being downward from the north. Toward the east end of the park, however, as the highway dips to pass below Jefferson Drive, it runs into the deep through cut which characterizes it from there to the end of the project. A 4-ft. chain link wire fence at each side effectively excludes pedestrians for the entire distance through the park.

Overhead and Under-Crossings in Park Section. Concrete used in the overhead crossing superstructures was a 1:1.7:3 mix by weight designed to develop about 6000 lb. per sq. in. in compression. Effective moisture was not allowed to exceed 6 gal. per sack of cement. Mall vibrators were used for compaction.

Stairways and South End of Pedestrian Overhead at the Arena.
Photo by Courtesy of Missouri State Highway Department.

The main Tamm Ave. overhead is a 66-ft. steel rigid frame structure on a 24° 38′ curve with a 32-ft. roadway and two 5-ft. sidewalks. The sidewalks are 12 in. above the roadway and are protected with a structural steel handrail. Cost, $32,795.

Tamm Ave. pedestrian crossing is a continuous plate girder of three spans—one 34-ft., one 58-ft. and one 66-ft. with a 6-in. concrete deck, 8 ft. in width. The entire structure is covered with a sheet steel roof, electrically welded to waterproof the joints and is supported on 6 in. H columns. Cost, $13,566.

The overhead crossing at Hampton Ave. consists of three steel girder spans—two of 37 ft. each and one of 81 ft. The roadway is 50 ft. wide and there are two 6 ft. sidewalks, raised and protected by guard rail as at Tamm Ave. Cost, $41,317. A complete clover leaf connection is located at this point.

The next crossing is a pedestrian overhead at the Arena, where many important functions are held. It consists of one 43-ft. and one 54-ft. steel girder span on concrete bents. The deck is 12 ft. wide and 6 in. thick, and there is a roof similar to that at Tamm Ave. The south end of the span is supported by a tower with two stairways leading to the street level. Cost, $15,136.

There are three under-passes between the Arena and Jefferson Drive. The first is for pedestrians at Forest Park Highlands, a commercial amusement park. It has a barrel 53 ft. long and 12 ft. wide, reached at each end by two stairways, each stairway having an entrance house at street level. On the south side there is also a 48 ft. street car loading platform with a concrete canopy. Cost, $18,881.

An equestrian under-pass is provided at Mackland Ave. to give access to the park from several riding stables in the vicinity. The barrel is 53 ft. long and 12 ft. wide, with an open ramp on an 8 per cent grade at each end. Cost, $14,512.

There is a pedestrian under-pass opposite the mounted police station east of Mackland Ave. The barrel is 59

Looking from Boyle Ave. toward Tower Grove Ave. Bridge, Sept. 14, 1936.

Photo by the Author.

ft. long and 8 ft. 2 in. wide, and is reached by a single stairway at each end. There are stairway entrance houses similar to those at the Arena. Cost, $14,483.

A modified clover leaf intersection is provided at Jefferson Drive at the east end of the park. The structure carrying the drive over the highway is a 56 ft. steel rigid frame bridge with counterfort U abutments. Roadway width is 32 ft. and there are two 5 ft. sidewalks. Cost of bridge and abutments, $25,043.

Looking East from Taylor St. along Highway Cut, Sept. 14, 1936.

Photo by the Author.

Kingshighway Overhead. Kingshighway Blvd. is carried over the Express Highway by a 54 ft. concrete rigid frame span with cantilever abutments. The bridge, 134 ft. 6 in. in width, carries two motor traffic drives and double electric railway tracks. One motor traffic drive is a 40 ft. concrete slab with a 10-ft. penetration macadam widening on the west side and the other, a 26-ft. asphaltic concrete surface with 5 ft. concrete widening on each side. Cost, $82,120.

Central Deaf Institute Pedestrian Overhead. This structure is similar in character to the other pedestrian overheads, but is longer. Its cost was $35,556, including adjacent retaining walls.

Crossings East of Kingshighway Blvd. Between Kingshighway Blvd. and the end of the present project at Hawk Ave., the Express Highway is intersected by six streets, each crossing it by an overhead structure.

Five of these are of concrete rigid frame design carrying a 36-ft. roadway and two 6-ft. sidewalks. The concrete is a 1:1.9:3.4 mix by weight, compacted with a mechanical vibrator. The lengths and costs are as follows:

Taylor Avenue, 56 ft. span	$10,362
Newstead Avenue, 56 ft. span	10,084
Tower Grove Avenue, 63 ft. span	11,853
Boyle Avenue, 55 ft. span	10,255
Sarah Street, 55 ft. span	15,051

These costs do not include adjacent retaining walls and bridge wings, which total $104,701.

The West Papin St. crossing is a 125-ft. steel truss on concrete abutments, on a 61° 27′ skew. There will be a 36-ft. roadway with two 8½ ft. sidewalks. The deck is of special concrete of 1:1.9:3.4 mix. Cost, $39,516, exclusive of retaining walls, etc.

The Highway Depression. The sides of the highway cut are sloped, toe walled, or full walled according to conditions at various points. The short block between Tower Grove Ave. and Boyle Ave. in particular is conspicuous because of its high retaining walls.

Traffic Connections at End of New Construction. From Sarah St. a 4 per cent rise brings the pavement to a grade connection with Hawk Ave., where it forks, the right branch, 425 ft. long, going to the intersection of West Papin St. and Vandeventer Ave., from which point traffic can move with only a slight jog to Chouteau Ave. and thence direct to the Municipal Bridge over the Mississippi, or can turn southwest in Vandeventer Ave. The left branch turns into Hawk Ave. to make a short connection with Market St. and so with the main business district, or with Vandeventer Ave. leading to the north.

Retaining Wall Construction and W. Papin St. Truss as Seen from Taylor St., Sept. 14, 1936. *The wall is founded on solid rock in the sheeted trench in right foreground.*

Photo by the Author.

The proposed ultimate development at this point is for a middle branch to cross Vandeventer Ave. by an overhead structure to the Chouteau Ave. viaduct. The distance is approximately 0.2 miles; and the project will be let in approximately 30 days.

Contractors and Labor on the City Section. All labor was secured from the American Federation of Labor with the consent of the Missouri State Employment Service.

Newstead Ave. Overhead, Sept. 14, 1936. *Keystone Skimmer Scoop Clearing Up Debris.*
Photo by the Author.

The seven overhead and subway structures west of Jefferson Drive were built by Fruin-Colnon Contracting Co. of St. Louis. Grading and sewer construction on this same section were done by Ansbro-Maguire Co. of St. Louis.

The Jefferson Drive and Kingshighway structures, as well as the paving from the beginning of the project to

Looking East from Sarah St. Bridge to the Pavement Fork at Hawk Ave., Sept. 14, 1936.
Photo by the Author.

the west side of the Kingshighway structure, were built by the Webb-Boone Paving Company of St. Louis.

All grading, paving, and structural work to the east of Kingshighway Blvd. is being done by Powers-Thompson Construction Co. of Joliet, Illinois.

Right of Way. The City of St. Louis provided the right-of-way on this section. Its cost was approximately $750,000.

Hawk Avenue to Municipal Bridge

It is possible that an elevated thoroughfare will be built from the end of the new Express Highway on Chouteau Ave. viaduct to the Municipal Bridge, but because of the great cost it is not likely that this project will be undertaken for some time. For the present, therefore, Chouteau Ave., in its existing condition, will form the final link in the Express Highway.

Making the Highway Safe for the Motorist

H. D. Barnes, state highway engineer for Kansas, in an address before the National Safety Congress on Oct. 7 asked for coordination of the efforts of all state highway departments that would "eliminate every mystery and surprise for motorists that exists in the peculiarities of road construction."

Speaking before a special session for state highway officials, Barnes said "city, county and state lines should not exist for the man behind the steering wheel. Confusion must be eliminated from the driver's mind as to what he is expected to do on account of conditions inherent in the road as he passes from one jurisdiction to another.

"Engineering skill has gone far in spanning great rivers, crossing swamps, deserts and mountains, but the problem of highway safety lies unsolved, a stout barricade directly in our path of progress. It is a challenge that can be solved with the only effective weapons that ever won a battle—intelligence, team work, action."

Barnes said it was "high time" that state highway departments unite and "go to the mat" in what he termed "this greatest of all wars—the war on needless destruction of human life and property in which the enemy is an intricate composition of human negligence." He said the substance of the highway engineer's job was to construct roads so that human or mechanical failure would produce a minimum of injury and property damage from automobile accidents.

Tests of Artificial Snow Fences

In a paper presented at the 22nd Michigan Highway Conference, E. A. Finney, Assistant Professor of Civil Engineering, Michigan State College, summarizes as follows the results of wind-tunnel tests at the Engineering Experiment Station, of the various types of artificial snow fences:

1. Each type of snow fence produces a characteristic eddy which remains constant for any wind velocity and height and type of barrier. The distance from the fence to the end of the eddy varies with the height of fence by the ratio of 15 to 1 respectively. This is true of the horizontal and vertical-slat fence only. The solid-type fence varies by the ratio of 10 to 1. In other words, a horizontal-slat snow fence 4 feet high should be placed at least 60 feet from the travel way.

2. The size and shape of the eddy area produced by a fence will control the size and shape of the completed snowdrift. The fundamental shape of the eddy and snowdrift is in the form of an ichthyoid curve.

3. A snow fence with a ratio of 1 to 1 for the width of slats and the opening between the slats gives the best results. A barrier with 50 per cent open spaces should be the most efficient.

4. Raising the bottom of the fence more than 12 in. above the ground reduces the effectiveness of the fence at high-wind velocities. A height of 6 in. above the ground gives the best results for all conditions.

5. Any inclination of the fence from the vertical reduces the length of the eddy and the drift. However, an inclination of not more than 30 degrees with the wind tends to keep the bottom of the fence clear.

6. The position of the maximum depth varies with the type of barrier, wind velocity, and density of snow. This distance may be any length from zero at the barrier to two-thirds the length of the drift. The end of the drift will remain constant.

WIDENING WOODWARD AVENUE DETROIT, MICH.

By MURRAY D. VAN WAGONER
State Highway Commissioner of Michigan, Lansing, Mich.

M. D. Van Wagoner

AMONG the many important highway construction projects undertaken in Michigan, the widening of 2.557 miles of Woodward Avenue in Detroit ranks among the first both because of the cost and difficulties it involved, and because of the improvement in street and traffic conditions which it produced.

Woodward Avenue is the central and principal thoroughfare in Detroit's system of radiating avenues. From its foot at the ferry docks on Detroit River it runs northwesterly for nine miles to the north city limits. From there it continues as the Dixie Highway (U. S. 10), first through a densely populated suburban area and then through rich agricultural country and such thriving industrial centers as Pontiac, Flint and Saginaw.

The three most important points on urban Woodward Avenue are the Campus Martius, one-third mile from the river; Grand Circus Park, a third of a mile beyond the Campus, and the intersection with Grand Boulevard, 2½ miles farther out.

Campus Martius is the center from which the city's several most important arteries radiate. The City Hall fronts on it and many of the leading financial institutions and office buildings are nearby. From Campus Martius to the river, Woodward Avenue carries traffic between this central business section and the old wholesale and shipping district along the river.

Grand Circus Park is in the center of a newer hotel and theater district and the focus of a secondary system of radiating streets serving the downtown mercantile area. Between Campus Martius and Grand Circus Park, Woodward Avenue is preeminently the shopping center of the city. To this third of a mile of great department stores and miscellaneous shops the people of Detroit and of a considerable part of Michigan come to make a large proportion of their purchases.

Grand Boulevard is a semi-circular parkway which with the river encloses practically all the older part of the city. Woodward Avenue, between its intersection with the Boulevard and the city limits has developed into a series of attractive and prosperous neighborhood

View from Grand Circus Park North Shrowing Moving of Steeple of Central M. E. Church

Slabs Surfaced to Prevent "Shoving." In Foreground Is Grooved Slab While in Background Another Slab Is Being Poured

trading centers with here and there groups of public buildings which serve the northerly portions of Detroit proper and the enclosed municipality of Highland Park. Beyond the limits, a splendid dual highway consisting of two 44-ft. roadways leads to Pontiac and beyond.

Why the Widening Was Necessary

But until very recently property developments on a long section of Woodward Avenue between Grand Circus Park and Grand Boulevard were in a run-down condition.

The reason for this sick spot in an otherwise fine avenue was that in this section Woodward was a deformed and crippled street. South of Grand Circus and north of the Boulevard it was 120 ft. wide with a spacious 90-ft. roadway, but here at the doorway of its business district it was only 74 ft. wide and its teeming traffic was crowded into a narrow 50-ft. roadway.

Back in 1910 when the population of Detroit was a little over 400,000 the Woodward Avenue bottle-neck was an almost unnoticed blemish in the city's street system, but in 1930 when the population had almost quadrupled it had become a major obstacle to the orderly development of a great metropolis.

More vehicles entered Detroit by this highway than by any other, a large proportion of them bound for the downtown section, and when they reached the Boulevard they had but two alternatives: either to bore their way through the heavy traffic congestion of 2½ miles of constricted roadway, or detour onto a parallel street.

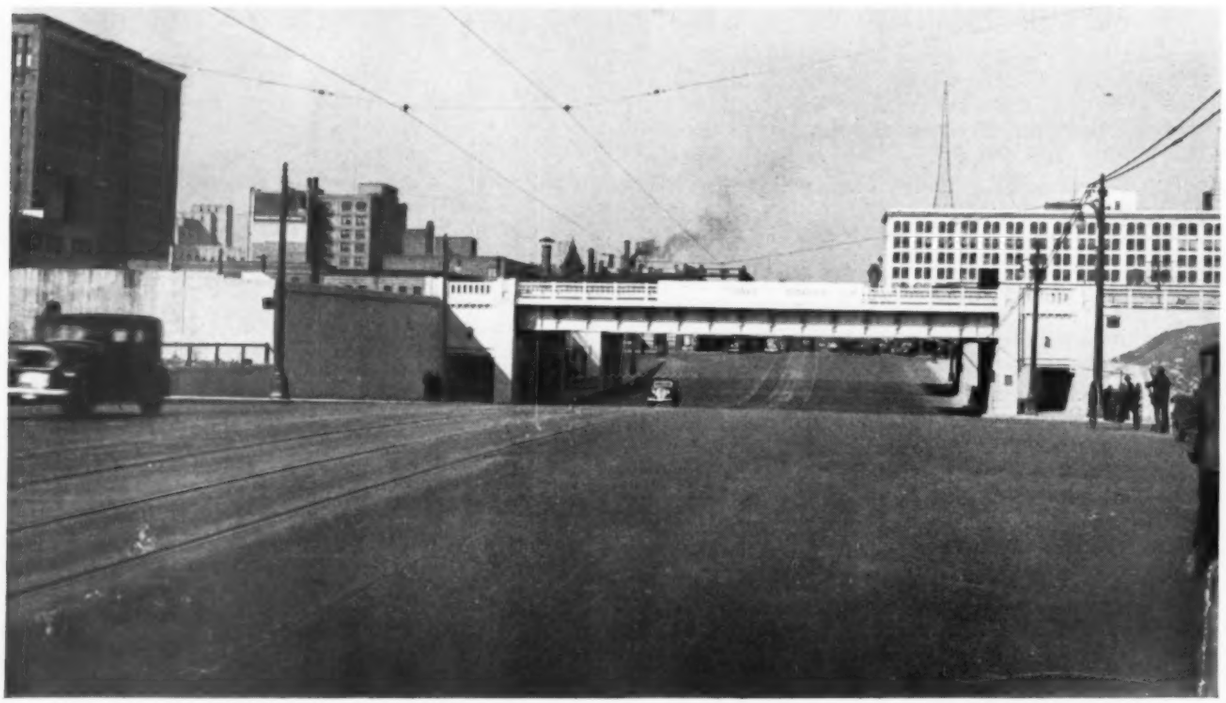
How serious this dislocation of traffic was, is indicated by a traffic count taken in 1930, which showed an average 12-hour movement of 22,543 vehicles on Woodward at the Boulevard, while down toward the lower end of the bottle-neck this movement had dwindled to 14,671 vehicles. And in addition to this vehicular traffic the Woodward Avenue streets cars carried the heaviest surface line traffic in the world.

First Step Taken in 1930

The problem of widening Woodward Avenue had been agitated for some years and by 1930 some steps had been taken to make the project possible. Condemnation proceedings had been instituted and a large part of the necessary additional right-of-way was ready for transfer to the city, but, due to depression conditions, the city was without funds to complete the purchase.

At that time a contract was entered into by the City of Detroit and the Michigan State Highway Department which provided that they should bear equally the cost both of purchasing the right-of-way and of constructing the wider avenue. The city was to handle the purchase of land and the clearing of the right-of-way while the Department was to make annual payments to cover its share of these costs and to assume all responsibility for the supervision of construction. But lack of funds continued to delay the project.

However, in July, 1933, almost coincident with the beginning of the present State Highway administration, Federal grants to the Department made definite action



New Grade Separation Made Room for Widened Avenue and Received Award of American Institute of Steel Construction

Upper Woodward. Looking North from the Detroit Art Center Up the Completed Avenue

possible. The State Highway Commissioner promptly made the first payment to Detroit authorities on the Department's promised contribution to the widening costs, and plans were completed for starting construction the following year.

The selection of the right-of-way was determined after careful study. The old street was straight and to preserve its line it would have been necessary to widen on both sides equally. The prohibitive cost of following such a plan and the varied character and value of the structures on the two sides of the avenue led to the adoption of a more practical procedure.

The widening operations were carried on on alternate sides of the avenue. This resulted in changing the axial line of the street from a straight line to long easy curves and tangents. The finished highway is not only an efficient artery for the smooth flow of its heavy traffic but affords pleasant vistas for the eyes of the incoming visitor.

Three-Year Construction Program

Actual work commenced in 1934 and was carried to completion in the construction seasons of that and the two succeeding years. In 1934 a section 0.68 miles long was widened from Baltimore Street, just south of the Boulevard, to Kirby Street at a cost of $250,000. In this section was a dual grade separation with the tracks of the Michigan Central, New York Central and the Grand Trunk Western Railroads, and this was replaced at a cost of $317,700.

In 1935 the operations were continued south from Kirby Street to Vernor Highway, a distance of 1.54 miles, at a cost of $606,131. The final section from Vernor Highway to Witherell Street on the south side of Grand Circus Park, a distance of 0.337 miles, was started in 1936. This last project was completed with the exception of the block south of Vernor Highway on Sept. 1, and would have been entirely completed on that date but for unforseen delays in clearing the right-of-way in the block in question. By Oct. 15 the remaining work should be finished, 15 days before the required completion date. The estimated cost of this 1936 project is $147,600.

Construction for the whole widening job is estimated to cost $1,321,431, and this with the right-of-way cost of $9,806,454 brings the estimated total cost of the entire operation to $11,127,885.

The widening of the 74-ft. street to the full 120-ft. width of the rest of Woodward Avenue was carried forward in three steps: First, clearing the right-of-way under the supervision of the Detroit Department of Public Works; Second, rebuilding of underground plant by the various public utilities concerned; and Third, actual construction of the new thoroughfare including the dual grade separation under the supervision of the State Highway Department.

Moving an 80-Year-Old, 168-Ft. Steeple

Probably the most spectacular episode in the entire widening process was the moving of the steeple of Central Methodist Episcopal Church at the northeast corner of Woodward Avenue and Adams Street. For reasons of sentiment it was required that this 80-year old structure be preserved approximately intact but because of surrounding building development it was impracticable to move it as a whole.

It was decided to cut off the front 30 feet of the main structure, to rebuild the front wall across the trun-

Equipment on Job Building Railroad Undercut in Widening of Woodward Avenue

Last Section of "Bottle-Neck" Before Widening. Looking from Vernor Highway to Grand Circus Park

cated remaining section, and then to move the 168-ft. steeple back to fit into a place that would be left for it. This was done and when the 4,000,000-pound masonry pile with a base of only 30 by 30 ft. was finally loaded onto rollers the city waited with bated breath while a battery of screw jacks pushed it inch by inch into its permanent position. The job of moving this great steeple 27 ft. east and 6 ft. south was successfully completed in less than a week.

But although the church steeple got most of the headlines there were other less publicized phases of the work which caused more anxiety among responsible officials. For instance, the rebuilding of the public utility lines was an operation of great complexity, while the maintenance of certain essential transportation and public safety services during the whole period of construction demanded constant care and cooperation from all concerned.

Regarding the rebuilding of the public utilities' underground plant it is only necessary to note that all except the public lighting ducts were placed under the sidewalks to guard against tearing up the roadway in making future service repairs.

Pavement Construction

In selecting the type of pavement to be built, sheet asphalt on concrete base was chosen in order to conform to the general practice in Detroit. The concrete slabs were poured 18 ft. wide by a maximum of 40 ft. long and were laid five abreast, the center one being the track encasement. The two outer slabs on each side are 10 in. thick except where they join the encasement where the thickness is increased to 14 in. This construction gives six planes of weakness longitudinally with transverse joints every 40 ft. at most.

To afford adequate support for the car tracks, the tracks encasement is 15½ in. thick. Track drains were placed in a trench 30 in. below the encasement excavation and this was covered with compacted slag or crushed stone which was also spread to a depth of 4 in. in the excavation itself. The track encasement was poured in two courses, the first just thick enough to form a base for the track ties and the second poured after ties and rails were laid.

All slabs were surface finished with a finishing machine and were then scored transversely with ⅜ in. grooves 2 in. apart. This treatment of concrete base surface was developed by the State Highway Department two years ago and serves to prevent longitudinal shoving of the asphaltic surface under traffic.

A useful practice which was introduced during the latter part of the widening construction was that of setting short ¼-in. rods in the concrete in such a position on the outer slab as to serve as braces for the curb forms. When the curb was completed a few taps with a hammer loosened the rods and permitted their removal.

In order to produce a uniform grade on the traffic way and avoid the usual humps at street intersections, the pavement was designed without any warping outside the parking line at these points. The asphalt surface consists of a 1½-in. binder course and a 2-in. wearing surface except for the 6½ ft. along the curb where the wearing surface is brick.

On each of the paving projects construction continued 24 hours a day. Setting up forms and other preparatory work was done during the day and all concrete was poured at night. For the base and track encasement this concrete was brought to the location in transit mixers while for all the rest of the work batch trucks were used. This program not only expedited construction but relieved traffic congestion in the area during the busiest hours.

Two Steel Overpass Structures Constructed

The replacement of the grade separation in the northern section of the Woodward Avenue bottle-neck necessitated the construction of two steel overpass structures and the concrete sub-structure which carried them. The latter consists of the arched abutments at the curb lines supporting the 96½-ft. plate girders, and the panelled retaining walls at the property lines. Although the dual structure is treated architecturally as a single unit, the fact that the two railroad crossings are spaced well apart permitted building the temporary trestle between them and greatly simplified the problem of maintaining regular train service on three of the five tracks involved.

The new separation unit not only spans the full street and sidewalk width of Woodward Avenue but is architecturally in keeping with the importance of its location. Last year the American Institute of Steel Construction, Inc., awarded this structure first honors in its cost class for beauty and fitness of design.

Handling Traffic During Construction

During the whole course of the widening operations one of the major considerations outside actual construction was that of keeping portions of the avenue open for street cars and police and fire equipment. That street car service was only interrupted for a few hours during all this period was due primarily to the fact that widening from only one side threw the new center-line of the avenue far enough over to allow room for the construction of the new encasement and tracks without disturbing the old. Thus only short sections of temporary track were required and the cut-over onto the new construction was accomplished on each project in the minimum of time.

The police and fire authorities requested that certain cross streets be kept open and at these intersections quick setting cement was used to expedite construction. Part width construction and temporary bridges were means also used to avoid shutting off traffic across the area of the projects. Altogether, excellent cooperation among the various public agencies and private interests permitted the completion of the widening operations with few major delays, practically no interruption of essential services, and the least possible inconvenience to the public.

The results of this three-year construction campaign are repaying and will continue to repay its cost many times over. Its prime objective of freeing traffic from a dangerous and unbearable obstacle, of course, has been attained, but there are other advantages which can by no means be disregarded. Two and a half miles of frontage values have been increased to an amount at least commensurate with the expense of the improvement and this increase has in turn been reflected in an immense amount of building activity which is now only getting under way.

It is impossible at this time to predict the transformation which will result from the elimination of the Woodward bottle-neck. But one thing is certain: with its dual highway extension to Pontiac, Woodward Avenue is now, as was once predicted, "the most magnificent state trunk-road entrance to an American city."

▼

Standard Road Widths in Great Britain

Highway Research Abstracts for September contains the following, the matter being taken from a circular of the British Minister of Transport:

The widths set out are based on the report of a committee appointed by the Minister of Transport. Following is an abstract of the conclusions:

(a) The width for each lane of traffic should be 10 ft. If a roadway of not more than 2 traffic lanes is likely to carry a large proportion of industrial vehicles, the width should generally be increased to 11 ft.

(b) Where a road is to carry 400 vehicles at the peak hour, or in case where more than 2 traffic lanes may be necessary, the roadways should be divided to separate opposing traffic. This may often be justified solely on the grounds of public safety. (Two pedal-cycles may be regarded as equivalent to one vehicle.)

(c) The standard widths adopted should provide for such future widening of the roadways, cycle-paths and footpaths, as may become necessary. Dual roadways should be separated by a central reservation of the maximum width consistent with the layout of the road.

(d) Cycle tracks may be justified on grounds of public safety or on grounds of economy if their construction will avoid the necessity of widening an existing roadway. Cycle tracks should normally be 6 ft. wide, and additional width, when necessary, should be added in units of 3 ft. Where practicable, the tracks should be separated from the roadway and footpath by verges. Where sufficient width is not available, a curb may be used.

(e) Minimum standard widths in ordinary circumstances:

Proposed layout	Minimum standard widths to be adopted
Single roadway, not exceeding 30 ft. with footpaths	60. ft.
Single roadway, not exceeding 30 ft. with footpaths and cycle tracks	80 ft.
Dual roadways (each with 2 traffic lanes) with footpaths	80 ft.
Dual roadways (each with 2 traffic lanes) with footpaths and cycle tracks	100 ft.
Dual roadways (more than 2 traffic lanes each), footpaths but no cycle tracks	100 ft.
Dual roadways (more than 2 traffic lanes), footpaths and cycle tracks	120 ft.
Where further provision is required for wider cycle tracks, wider verges for improved visibility or equestrian traffic, greater space for services or improved amenities	140 ft.

The above standard widths insure that the road shall possess a proper degree of amenity in the shape of grass margins, space for trees and shrubs, and shall not consist merely of paved strips.

Where cuts or embankments occur, the width for the section should be increased by one or more 20-ft. units. The greatest standard width is 160 ft., but regulations prescribe other widths up to 440 ft.

It is desired to further the interests of public safety by construction of service roads for access to property, and to limit and prescribe the sites of new means of access to the road. Where service roads are to be built parallel to the road, they should be on land outside the standard width.

In order to prevent ribbon development, it is wise to discourage sale of frontage strips or building plots along the road. The number and position of new street entrances should be fixed by the highway authority in a way to encourage development on the new streets rather than that of ribbon development along the traffic roads.

▼

Dr. Tabler Appointed Chairman of Committee on Safe Highways

Dr. H. E. Tabler, Chairman of the Maryland Roads Commission, has been appointed Chairman of the Committee on Safe Highways that is being organized by the American Road Builders' Association.

Governors of 21 states have accepted invitations to serve on the committee, and governors of all other states are expected to become members or to designate personal representatives. The governors are honorary members. Advisory members will include heads or representatives of all national organizations that are interested in highway safety.

Organization of the A.R.B.A. Committee on Safe Highways is the first national effort that has been undertaken for the elimination of motor vehicle traffic hazards due to improper and inadequate highway construction. The committee will make its first report at the 1937 Convention and Exhibit of the American Road Builders' Association in New Orleans during the week of next Jan. 11.

MARYLAND STATE ROADS OUTMODED

County Road Standards Adopted—Grading Proceeding On 24-Hour Fasis

By VICTOR J. BROWN

Publishing Director Roads and Streets

MARYLAND was a pioneer in the roadbuilding program of the Nation. This state completed its system of state roads back in 1915. Construction since that time has been of two kinds up until 1935. One type was the widening and resurfacing of roads already built; the other type of construction has been the addition of new mileage to the state system, employing for this, as it occurred, the then modern construction designs.

Maryland has only two classes of roads; viz., State Roads and County Roads. The county roads are similar in service and traffic characteristics to the Township road systems of the Middle West or the Town road systems of New England. There are approximately 4,000 miles of state roads and 11,200 miles of county roads. The legislature in 1933, in an effort to reduce taxes, permitted the counties to turn their roads over to the state under the following provisions: The act by which this was done provided that maintenance and betterment be at the discretion of the authorities of the various counties. The proceeds of 1½ ct. of the gas tax revenue could be applied for reducing county road debts on outstanding highway bonds of the various counties, for maintenance, or for the construction of lateral roads. All but three counties, Anne Arundel, Baltimore, and Harford Counties, requested the commission to maintain their roads, and in the rest of the counties a combination of all three of the propositions was applied.

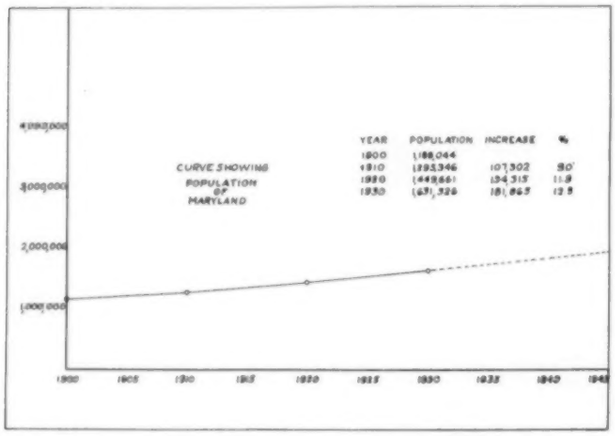


Fig. 1—Curve Showing Population of Maryland. It Is Projected to 1945.

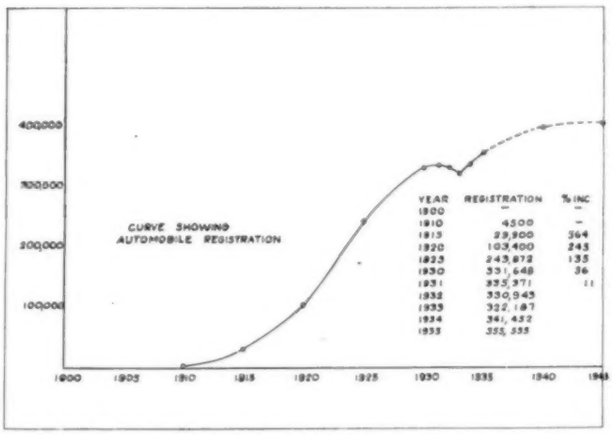


Fig. 2—Curve Showing Automobile Registration and a 1945 *Prediction.*

State Road System

First road construction work in Maryland was done by turnpike companies between 1802 and 1825. These roads were the main highways leading out of Baltimore and probably never exceeded 150 miles in total length. The value of roads as lines of communications, arteries of commerce, and for developing the hinterland was recognized officially as early as 1898 when the legislature appropriated $10,000 for the use of the Maryland Geological Survey for highway investigations and to give advice to the counties on highway problems. Their report, printed in 1899, states as follows:

"No subject today more demands the attention of the people of Maryland than that of road construction. When hundreds of thousands of dollars are being annually appropriated for our highways, it is pertinent to inquire whether this outlay is intelligently made, and if not, whether better methods of road construction cannot be adopted in order that the people of the state may secure a larger return for the money which they expend."

This querulous statement is as true today as it was 37 years ago, due this time to the unexpected increases in motor vehicles using the highways.

In 1908 the State Roads Commission was established. One of the first acts of the commission was to select a system of main roads. About 1,200 miles were adopted; representing the main arteries connecting Baltimore with the counties and the county seats with each other. In 1910 the legislature placed the highway work of the Maryland Geological Survey under the jurisdiction

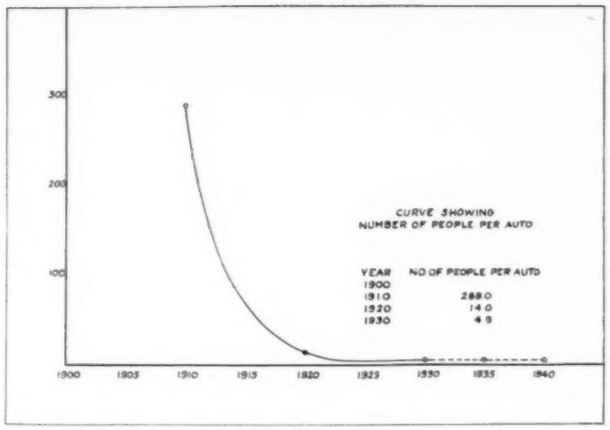


Fig. 3—Curve Showing Relation of Motor Vehicle Registration to Population.

of the State Roads Commission. Waterbound macadam was the type of construction generally employed at that time. This short historical outline of how the state road system has developed is given in order to lay a background for substantiating a statement to be made later, that most of the roads should be scrapped and new modern highways built which take into consideration not only present traffic requirements but future traffic and future motor vehicle development. Additions to the construction completed in 1910 did not entirely keep pace with what was then modern engineering design. In those days horse drawn traffic was the governing factor, motor vehicle registration in the whole state totaled only about 4,500 vehicles. By 1915 1,300 miles of road were completed.

In some sections of the state local materials satisfactory to carry the traffic of that time were available and the mileage completed with it. In 1912 the first experimental concrete road was built and in 1914 this type was adopted as a standard of new construction. But as has been stated, most of the main arteries were completed by then with water bound macadam. By 1915 motor vehicle registrations had increased to approximately 30,000 and the roads just completed had begun to fail. The commission established a maintenance department in 1910, the legislature providing that proceeds from the licensing of motor vehicles be used for maintenance. This money was used in surface treating the macadam roads, narrow as they were. It is recalled that they were designed for horse traffic. Since that time, as traffic increased, it was found that some types of roads originally constructed were not of sufficient width or strength and it became necessary to develop methods of widening and strengthening. A policy of widening by adding concrete shoulders from 3 to 10 ft. in width was adopted in 1918 and has been followed since. The old surface between the concrete shoulders was covered with some type of black top construction. In many cases curves were widened and superelevated.

Hence we see a system of roads that has, like Topsy, "just growed." No definite mileage has at any time been adopted by the legislature as a primary road system. The Maryland law required the state to add mileage that had been constructed in the counties to a certain standard. Year by year this was done until now the system aggregates 4,000 miles which not only ties up county seats and important towns but also interlinks small hamlets directly with each other and crossroad corners with one another. There is a crying need for legislative action toward adopting a state primary system.

As one drives over the state roads one is impressed with the narrow rights-of-way, the wavy or rolly-coaster center-line design, the many narrow surfaces, the either not wide enough or too wide bridges, the sharp curves —both horizontal and vertical, the lack of sight distance, the lack of adequate signing, the lack of side ditches for drainage, and the uneven and bumpy riding surfaces. Many of these factors are grouped together on certain roads and the itinerant driving critic is liable to think that the State of Maryland has had men in authoritative capacities who lacked vision and imagination or who were not bold enough to take what appeared to be

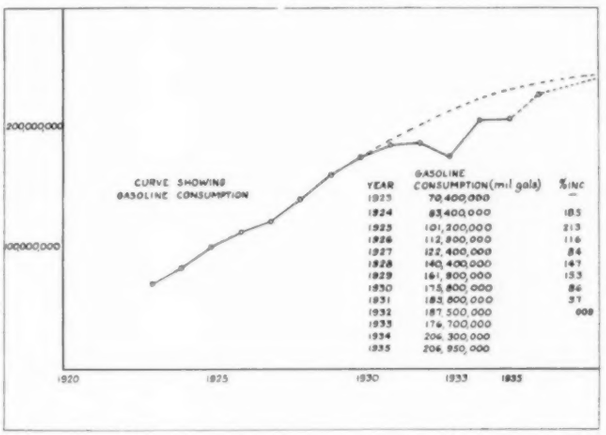


Fig. 4—Curve Showing Total Gasoline Consumption Projected to 1945.

drastic steps toward building for the future. It is possible that this obtains because of the frequent changes in membership of the commission, which necessitates, at each change, that the new men be educated to the ramifications of highway administration, construction and maintenance. Another important factor that has undoubtedly influenced this condition is the fact that new members, unfamiliar with data on the rapid development of automotive transportation have not comprehended the necessity of gearing highway development with automotive development. In justice to the engineers

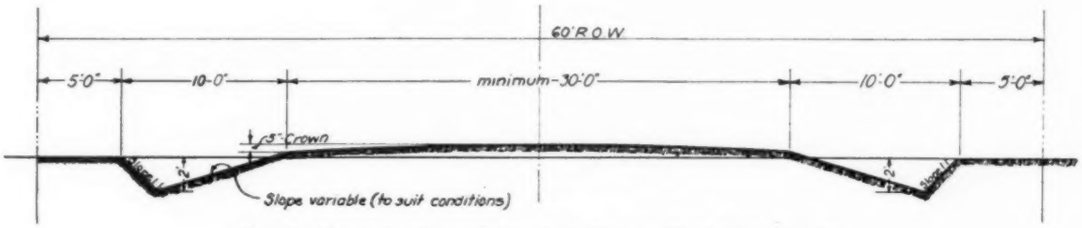


Fig. 5—Cross Sections of Standard County Road Construction.

STATE OF MARYLAND Report #21
STATE ROADS COMMISSION
District No. 8

Record of Operations of Auto Patrol Grader Unit No. 8-38658 Put in Operation 6/22/ 19 36
For Week Ending Sept. 19, 19 36
St. Mary's County First Election District 1 Benchville Road

WORK RECORD

Shifts per day 2 Hours per shift 12 Days 2 Total possible hours this period 48
Days worked 2 Total hours worked this period 24 Hours worked to date 766
Delays this period Total
Cause for delay 4 hrs. greasing, 11 ROW. not cleared, 7 hrs. not working.

OPERATING COSTS Accumulative Cost

MATERIALS	For Week Gals.	For Week Rate	For Week Total	To Date Gals.	To Date Total	Cal.	Remarks	Cost
Gasoline						55		6.99
Fuel Oil	50	.09	4.50	157	14.13	1206		108.54
Lubricating Oil	2	.33	.66	11½	3.80	67½		22.20
Grease (lbs.)	2	.11	.22	14	1.54	67		7.57
Tires (each)								

REPAIRS

Nature 1 Firestone Tire 5439L7, replace Firestone C-88880 (Front Tire)
1 New tire (left frontrear) 12.75 x 24 Labor $ Material $ 9.00 Cost this week $ 9.00 Cost to date $ 56.24
Total cost of Operating Unit for Week $ 46.6 To date 40.19 To Date $ 202.75 (total)
1 Bladen-$9.00 Cost of Operating Unit per hour for week $ .25 .24 To Date $ .26
Average fuel consumption per hour operated for week 1.2 gallons. 1.2 To date 1.5 gallons.

OTHER ITEMS

	No.	For Week Hours	For Week Rate	For Week Total	To Date Hours	To Date Total	Remarks
Tractor or Patrol Operator	2	48	45	$1.60	609	135.05	Foreman
Grader Operator							
Foreman	1	50	55	17.50	225	78.75	Stephen Benn
Chauffeur							
Labor	7	324	22½	7.20	1333	299.85	
Trucks							

MATERIALS

	Cost
Pipe (lin. ft.)	
Cement (bbls.)	
Sand (c.y.)	
Coarse Aggr. (c.y.)	
	Total Cost $

Total Cost of Operation including all items for week $ 126.29
Total Cost of Operation including all items to date $ 511.97
Miles of work completed for week .25 Rate per mile $ 378.00
Miles of work completed to date 1.5 Rate per mile $ 347.33
Approx. excavation completed for week 800 c.y. Rate per c.y. $ .15
Approx. excavation completed to date 2200 c.y. Rate per c.y. $ .16
Approx. Acreage Clearing and Grubbing for week A. To date 2.5 A.

REMARKS:
Resetting fence and digging outlet ditch-Road graded 28' wide

Work Anticipated for Ensuing Week—
Grader is now working on shaping and ditching roads.

K. O. Webb
Jr. Asst. Highway Engineer
Jos. Chaney
District Engineer

ORIGINAL—Chairman

Fig. 6—Sample Cost Record for Individual Grading Job on County Road.

of the commission it should be stated that the chairman of the Maryland State Roads Commission has practically unlimited power in regard to road policies and administration of road laws.

Now Governor Nice has given the State Roads Commission a free hand with instructions that they are to give the state the best service and roads possible.

In 1935 the State Planning Commission presented a Ten-Year program report to the State Roads Commission. This report, while better than nothing, is inadequate in many respects and was unsuitable to present to the legislature as a guide in framing legislation enabling the execution of a future road building program. It is, however, used as a guide by the P. W. A. authorities in passing on road work to be accomplished with P. W. A. funds. To date there has been no program submitted to the legislature for future modernized road construction. The State Planning Commission, Dr. Tabler states, will have a program to submit next January.

Mileage in the state system has nearly tripled what it was in 1915. Motor vehicle registration now is approximately 356,000, or more than ten times what it was in 1915, when the original state system was completed. The resulting increased traffic demands kept the State Roads Commission busy with maintenance, betterment and new construction. Planning for possible future demand was overlooked in the rush to provide road surfaces for this increased traffic. The State of Maryland now finds itself in the unfavorable position of possessing an antiquated highway system. Sight distance, horizontal and vertical curvature, shoulder construction, by-passes for cities and towns, grade crossing elimination, width of roadway, and width of bridges all are sorely in need of attention. While signing conditions are fair, they need to be modernized and improved at and near junctions.

Some new highway construction work is in progress but no definite plan for future development or for modernization has been adopted. An economic study will probably indicate that most of the state road system should be scrapped and new modern highways be built to accommodate not only present traffic but future traffic increase, future population increase, and future motor vehicle development. Chairman Tabler says that a program to accomplish this will be presented to the next session of the legislature next January.

State Highway Statistics

The population of Maryland, as shown by Figure 1, indicates a steady growth and an average increase of

County Road Before Widening. This Is Really a Good Road Comparatively.

Finished Grading Job on County Road. All Cuts and Fills Made by Motor Grader.

12 per cent per decade. Figure 2 shows automobile registration projected into 1945. Future traffic on the highways of the state is closely related to these two factors and others, all listed as follows:

a. Trend in population.
b. Automobile registration.
c. Number of people per motor vehicle.
d. Total gasoline consumption.
e. Traffic studies.
f. Business condiitons of the nation.

Figure 3 shows the relation of motor vehicle registration to population, projected to 1945. From this curve it is noted that in 1945 there is expected to be one vehicle per 4.3 persons. The much heralded two-car

Fill Made by Motor Grader. Note Heavy and Coarse Material.

family will not be an actuality then. Figure 4 shows the total gasoline consumption projected to 1945. This is one of the most accurate gauges of highway use available to the engineer. Traffic flow over the roads is in direct relation to the amount of gasoline consumed as a propelling fuel. The state made a traffic count from 1927 to 1931 and it is noted that the percentage of increase in traffic checked the percentage of increase in gasoline consumption during the period within one per cent.

Business conditions in the country are certainly on the upgrade. One economist for a large mercantile concern prepared curves indicating a rapid growth in business for the next six years. Other economists also predict a bright future. Both major political parties are striving to enhance the condition of the farmer. These indicators show that heavier traffic than exists at present is expected. Therefore it is logical to predict a minimum increase of 5 to 30 per cent by 1940 over 1930, considering all factors. It is expected that the state traffic and planning survey group now at work under the supervision of the United States Bureau of Public Roads will have obtained enough data by the time the next legislature meets, on which may be based economic and financial plans and proposals.

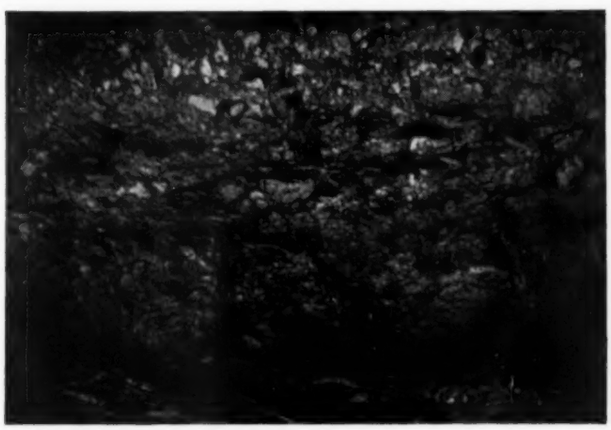
County Roads

As stated before, the legislature in 1933, permitted the county authorities to turn their roads over to the state for administration and maintenance but left it discretionary with the county commissioners as to how to use their share of the county revenues. The purpose in making this transfer was to reduce taxes on county farm property. The act accomplished its purpose. From

Cuts Made by Motor Grader.

1933 to 1935 the commission did mostly surface maintenance and improvement of drainage conditions in places. No standard section was adopted for betterment construction. About this same time the contracting fraternity was able to have a bill passed by the legislature which stipulated that any job costing over $1,000 must be let by contract. Therefore, it became necessary for the State Roads Commission, for the most part, to confine its activities to maintenance on the county road system.

When Dr. A. E. Tabler was appointed chairman of the commission he studied the problem of county road



Type of Material Cut by Motor Grader; All Loose Rock and Shale.

improvement and, upon recommendation of his engineering staff, decided to improve the roads by grading as a first step in a stage construction program. Stabilization of the traveled surface is to be the next step. A standard section with 30-ft. top and side ditches as shown in Figure 5 was recently adopted.

The commission expects to stabilize the surface on all roads graded this year.

To push the work a policy of 24-hour operation was adopted. The grading crews are operating on two 12-hour shifts. Grading machinery has been equipped with electric lighting facilities for night operation. It is claimed that successful results are being obtained. Certainly the efficiency of the grading units increase when considered on a monthly basis over former methods of operation. Maryland is probably a pioneer in night operation. Roads inspected by the writer which were graded at night are just as good as those done by daylight.

To date all grading has been done with either motor graders or tractors and pull graders. The latter equipment has done a far better job than the former.

Side ditches are a new thing to Maryland grader gangs in the hilly country and as a consequence they are hesitant to adhere to the standard. As they become more familiar with the idea of ditching the depth of side ditches will increase to the point of desirable section. In 1934 and 1935 roads were graded to whatever roadway could be gotten considering terrain, soil conditions, and right of way; which right-of-way in most instances was not over 30 or 33 ft. It is now a policy to grade a road only where a 60 ft. right of way can be obtained. All right of way must be obtained without cost to the commission.

When the roads were turned over to the state all machinery owned by the counties was also taken over. For the most part this equipment was either obsolete, too light and small, or entirely inadequate for the purpose. Fills as high as 6 and 8 ft. are being made by the motor graders and pull graders. The dirt is pushed up to 300 ft. by the units. Thank-you-mams, sharp grade changes and sharp curves are being eliminated. The old equipment could do no more than ordinary surface maintenance. Following is a table showing county road mileages and cost per mile of maintenance up to Aug. 31, 1936 from Oct. 1, 1935, the beginning of the fiscal year:

		Maintenance Expenditures		
County	Total County Mileage	Total for 11 Months	Per Mile per Month	Est. Cost per Mile Per Yr.†
Allegany	384.04	15,741.60	3.73	44.76
Anne Arundel*	.....	.....	...	....
Baltimore*	.....	.....	...	....
Calvert	131.10	6,540.68	4.53	54.36
Caroline	497.73	28,838.73	5.27	63.24
Carroll	733.56	65,466.00	8.11	97.32
Cecil	495.81	41,331.69	7.58	90.96
Charles	221.62	31,180.36	12.79	153.48
Dorchester	499.73	29,411.07	5.35	64.20
Frederick	1,038 26	52,220 59	4.57	54.84
Garrett	718.58	35,273.43	4.46	53.52
Harford*	.....	.....	...	....
Howard	284.54	38,238.39	12.22	146.64
Kent	249.89	24,971.05	9.08	108.96
Montgomery	614.46	34,848.90	5.15	61.80
Prince George's	471.09	41,490.45	8.01	96.12
Queen Anne's	380.48	33,439.68	7.99	95.88
St. Mary's	235.46	24,891.83	9.61	115.32
Somerset	296 72	29,431.54	9.02	108.24
Talbot	304.06	9,400.82	2.81	33.72
Washington	597.55	57,906.59	8.81	105.72
Wicomico	503.60	34,171.62	6.17	74.04
Worcester	478.26	20,821 39	3.96	47.52
Totals	9,136.54	655,616 41	6.52 (Avg.)	78.24

*These counties did not turn their roads over to the state.
†There was a period of time during the year when all equipment was used in grading and no smoothing operations done.

The maintenance cost per mile per month when multiplied by 12 gives a figure close to what will be expended over the fiscal year on which the commission is working and a figure to use in comparing with 1934 and 1935 figures. It must be borne in mind that the 1936 figures of cost per mile include the grading of 123 miles to the county standard.

COMPARISON OF COSTS PER MILE

Prior to 1933	$243.00*
Oct. 1, 1933 to Sept 30, 1934	187.53
Oct. 1, 1934 to Sept. 30, 1935	104.99
Oct. 1, 1935 to Sept. 30, 1936 (Estimated)	78.24

*This includes a certain amount of surface improvement and new construction, the amount of which is unknown.

This table clearly indicates the advisability of the employment of heavier equipment and the increased efficiency obtained by the concentration of effort on a standard section. Funds for county road work are obtained from a 1½ ct. gas tax apportioned to the counties on the basis of the ratio that the total road mileage in the county bears to the total mileage of roads in the state. Engineering and overhead costs are borne by state road funds. Thirty per cent of the 1½ ct. gas tax collections are paid directly to the City of Baltimore.

There is agitation among some of the county commissioners to have jurisdiction of county road work returned to the county by the next legislature. Chairman Tabler hopes to convince county residents that the present setup is superior by finishing the grading and stabilizing of a considerable mileage in each county, the total cost of which, when grouped with maintenance costs on the balance of the county roads will be less than what the counties had been spending and not obtaining new 30-ft. roads.

Accompanying table shows the mileages of county road graded this year, so far, and the average cost per mile of work. There is also a cost record which shows how individual costs of specific grading jobs are kept.

MILEAGE AND AVERAGE COST OF GRADING COUNTY ROADS.

County	Mileage of Grading Completed by State on County Roads	Average Cost per Mile
Allegany	4.16	252.25
Calvert	1.50	177.95
Caroline	3.00	259.29
Carroll	13.55	449.23
Cecil	7.30	39.92
Charles	10.00	222.29
Dorchester	4.85	174 73
Frederick	3.30	770.91
Howard	5.25	338.90
Montgomery	3.80	969.93
Prince George	7.50	428.39
Queen Anre	11.40	508.04
St. Mary's	11.90	242.42
Somerset	1.00	2,734.44
Washington	27.00	280.32
Wicomico	5.00	530.98
Worcester	2.75	605.87

THE WEATHERING OF ROCKS

By D. G. RUNNER

Assistant Materials Engineer
U. S. Bureau of Public Roads.

NOTHING endures. During geologic time, which covers millions of years, rocks have been laid down on sea bottoms, have been faulted, elevated to great heights only to be attacked by the processes of weathering. Magma, originally molten and slow-cooling, has during the course of time been gradually hardened into rock, and exposed at the surface by processes of chemical and physical actions. But with all these activities of formation, decomposition, erosion and re-formation, there is nothing lost to the system. Rather a change is made from the unstable toward a more stable phase. In time the mountain peaks are levelled, and the most durable granites are disintegrated. The speed with which rocks weather is a function of two main characters; namely, their composition, and the conditions of exposure. It is obvious that a granite will withstand more weathering than a shale or a loosely cemented sandstone. Likewise in the arid regions of southwestern United States, adobe will last for years, while in the severe northern climate this same material will rapidly disintegrate.

Weathering of the existing surface rocks is a feature that has been continuing ever since the beginning of time. It is imperceptibly carried on day in and day out; never ending. It is believed that a discussion of rock-weathering is of sufficient general interest to warrant the time and effort expended in preparing this paper. No originality is claimed for any of the facts presented herein. Instead, the references have been freely drawn upon for the data used. It is hoped that the information presented will prove of interest to the highway engineer, and to others interested in utilizing the natural resources for construction of highways and other incidental structures.

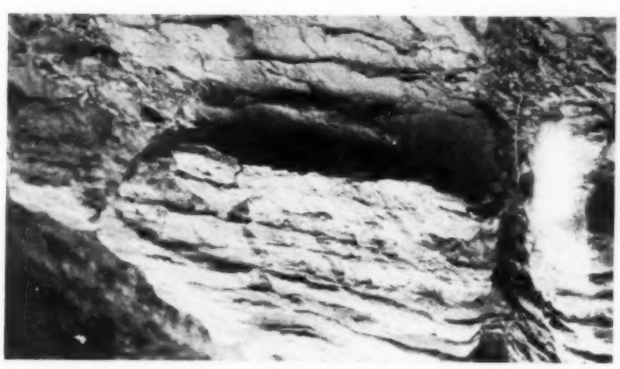


Fig. 1—Rock Weathering

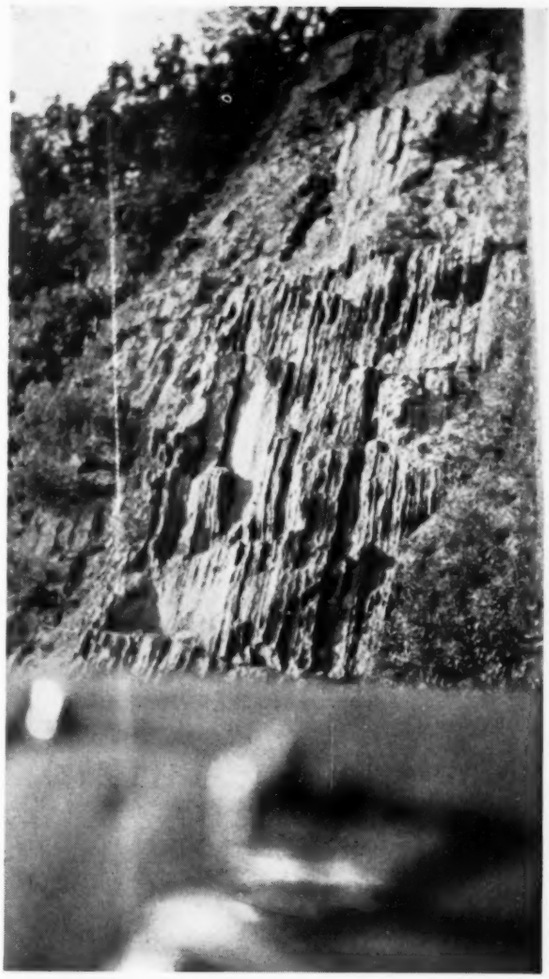


Fig. 5—Differential Weathering in Limestone. Note the Irregularity in the Exposed Face of the Outcrop, Due to Differences in Hardness of the Rock

Principles of Weathering

The processes under which "weathering" takes place may be said to consist chiefly of two kinds, namely, physical and chemical. They may operate singly or jointly. Merrill (1)[1] states that "the processes involved in this readjustment from unstable to stable compounds * * * are in part physical and in part chemical in their nature; they operate under ever-varying conditions, and through processes at times simple, or again complex. * * * It may be said at the outset, that whatever the forces engaged, they are, with a few isolated exceptions, superficial—they work from without downwards."

According to Clarke (2) "the breaking down of a rock is affected partly by mechanical and partly by chemical means. Mechanical agencies, such as the grinding power of glaciers, the pounding of waves, erosion by streams, the disruptive effects of frost, or the action of wind-blown sand, tend to separate the particles of rock and to furnish fresh surfaces to chemical attack. Unequal expansion, due to alternations of heat and cold, also assist in producing disintegration. * * * Solution, hydration, disintegration, and mechanical sorting are the successive stages of rock decomposition."

[1]Numbers in parenthesis refer to bibliography.

Fig. 2—An Outcropping of Limestone Showing the Effect of Solution

Mechanical Processes

The action of freezing water is a major factor in the disintegration of rock. Water upon solidifying at freezing temperatures expands approximately one-tenth, thereby exerting the enormous pressure of about 150 tons per square foot. All rocks contain pores and cracks through which the water may accumulate. Upon repeated freezing and thawing the individual grains of the rock will slowly fall apart. After each thawing period the water enters farther into the rock mass, and the constant "wedging" action of the ice results in complete breakdown of the material. This condition of disintegration is usually hastened in regions of moist climate. Frost action usually causes the rock to be fractured into angular shapes, that in turn are further exposed to frost action.

The movement of glaciers is another process by means of which existing rock masses are disintegrated. The slow movement of vast bodies of ice, creeping down mountain-sides acts as coarse "files" tearing away the rocks and finally grinding them to varying degrees of fineness. These glaciers in their travel, "pluck" and erode entire valleys, carrying the debris in, upon, and under the ice mass. Upon reaching lower levels and melting, the load is deposited to be further attacked by the elements. The amount of material ground by the ice action is enormous. Merrill (1) states that "the Aar in Switzerland is stated by Geikie to discharge every day in August some 440,000,000 gallons of water, carrying some 280 tons of sand. A portion of this is in a state of such minute subdivision as to remain a long time in suspension, and give the water a milky appearance for several miles. * * * At the foot of the Dana Glacier there is a small lakelet whose waters are of a peculiar greenish yellow color from the silt held in suspension, and which, when submitted to microscopic examination, is found to be made up of fresh angular fragments of various silicate minerals of all sizes from 0.35 mm. in diameter down to impalpable silt."

Strange as it may seem, animals and plants have a very definite effect upon weathering of rock. Plants of various kinds exist on rock surfaces, only to die and in time other plants take root upon the dead remains. Finally a soil-like material is built up, which retains moisture of rains and supplies humic acid to attack the rock. The wedging action of tree roots is quite commonly found in fertile regions. As the roots grow, they exert terrific force, disrupting the rock along weakened joints, thus allowing moisture to enter and further the destructive action. Earthworms and other burrowing animals provide openings through which organic acids enter to attack the rock.

Wind is still another effective agent of weathering, especially in arid regions. Merrill (1) states that "particles of sand drifting along before the wind become themselves agents of abrasion, filing away on every hard object with which they come in contact. * * * The grains go sweeping on, undermining cliffs, scouring down mountain passes, wearing away the loose boulders, and smoothing out all inequalities. Naturally the abrading action on exposed blocks of stone is most rapid near the ground, as here the flying sand grains are thickest." The effect of wind may also be seen in the recent dust storms of the middle west, where acres were denuded of the rich top soil.

Chemical Processes

Atmospheric air contains essentially oxygen, nitrogen, together with carbon dioxide and lesser amounts of argon. The chemical activities of the air penetrate the upper layers of the earth's surface to the level of the ground water. The region between this ground water and the surface is commonly designated as the "belt of weathering." It is in this area that the chemical work of the atmosphere is most effective in causing rock decomposition. Here the hydration, oxidation, and carbonation of the rock is continued.

Rain, falling through the atmosphere, carries oxygen and carbon dioxide in solution, together with other substances in varying amounts. This charged water upon entering the pores and crevices of the rock, attacks the mineral constituents. Rain water contains active gases, dependent upon the temperature, as shown by the following table:

COMPOSITION OF AIR EXTRACTED FROM RAIN WATER AT DIFFERENT TEMPERATURES
(Data from Clarke)

	0°	5°	10°	15°	20°
Carbon dioxide	2.92	2.68	2.46	2.26	2.14
Oxygen	33.88	33.97	34.05	34.12	34.17
Nitrogen (including argon)	63.20	63.35	63.49	63.62	63.69

The effect of rain water upon a rock causes the more soluble minerals to dissolve, and to form carbonates that contain lime, iron, magnesia, and the alkalies. By hydration, the feldspars are changed into kaolin, the magnesium minerals into serpentine or talc, the iron becomes limonite, while the quartz is changed little if any in composition. This process of solution and hydration has also caused an increase in volume, which probably affects the disintegration to a marked extent.

Clarke (2) states that "the evidence, both as found by experiment in the laboratory and by field observations, show that practically all minerals, certainly all of the important ones, are attacked by water and carbonic acid. The pyroxenes and amphiboles yield most

Fig. 3—A Granite Exposure Showing the Upward Graduation from Solid Rock to Soil

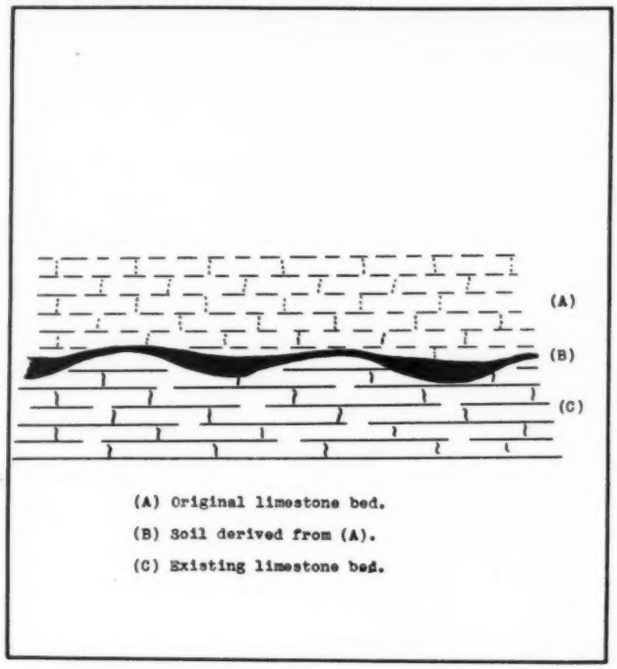


Fig. 4—A Limestone Formation Showing the Formation of Soil from the Upper Part of the Stratum (After Cleland)

readily to waters, then follow the plagioclase feldspars, then orthoclase and the micas, with muscovite the most resistant of all. Even quartz is not quite insoluble, and the corrosion of quartz pebbles in conglomerates has been noted by several observers. Among the commoner accessories apatite and pyrite are most easily decomposed, magnetite is less attacked, and such minerals as Zircon, corundum, chromite, ilmenite, etc., tend to accumulate with little alteration in the sandy rock residues."

In the oxidation process, the oxygen affects those minerals which are capable of absorbing additional oxygen, to form new compounds. The chief among these are the iron compounds, and it is due to these compounds that the red and yellow coloring matter is so pronounced in some residues. This formation of new compounds is accompanied by an increase in the volume occupied by the alteration products. For example, magnetite, upon changing into hematite, increases 2.5 per cent in volume. Hydration may also occur simultaneously, thus changing the mineral into limonite with an increase in volume of 64 per cent.

Referring to carbonation, Grabau (3) states that "this takes place on a vast scale, producing carbonates from the silicates, and setting free, thereby, silica or colloidal silicic acid. * * * The atmosphere furnishes much of the CO_2 which combines with the bases to form carbonates, either directly or indirectly through the mediation of plants." The combination of CO_2 with the magnesium, or iron silicates causes the formation of soluble compounds. The leaching out of these soluble compounds finally causes the rock to disintegrate.

Results of Weathering

The effects caused by weathering are many and varied. In the mountainous sections, the rough, jaged peaks so often noticed are the results of frost action induced by temperature changes. In other places, exposures of different character produce the result shown in Fig. 1. Note here the "cutting in" effect, caused by the more rapid weathering of the softer material. Exfoliation of rock, or the scaling off in layers, is often noticed in regions of wide temperature ranges. Rock surfaces may be highly heated by the sun during the day. This heating affects only the outer part of the rock, because of poor conductivity, and the resulting expansion causes the surface layer to scale off from the cooler mass beneath.

Grabau (3) holds that "changes of temperature in like manner affect the individual mineral constituents of the rock, as well as their association in the rock. Since each mineral has its normal coefficient of expansion and contraction under a given influence of heat or cold, it follows that irregular stresses and strains are set up within a rock mass of relatively coarse-grained minerals such as granite, and that this must lead to a slipping back and forth of the minerals upon each other with ultimate disruption or disintegration of the mass as a whole."

The products of rock weathering are usually divided into two classes, the residual and the transported. The residual products are those which remain in their place of formation, such as the clays. On the other hand, the transported products are those represented by river silt, glacial material, loess (wind blown), etc. Much of the residual material remains long enough on land to build up formations of vast thicknesses, while the ultimate destination of the transported material is the sea. The life cycle governing the history of decomposition products is shown in Figure 7.

Effect of Weathering Upon the Chemical and Physical Properties of Rock

As has been shown in the foregoing paragraphs, weathering has a profound influence upon rock. The

Mineral	Composition	Changes	Product
QUARTZ	SiO_2	Remains undecomposed	Sand grains
ORTHOCLASE (feldspar)	K_2O	Goes into solution as carbonate, chloride, etc.	Soluble material
	Al_2O_3, $6SiO_2$	Hydrated and combined to form hydrous Al. silicate, with liberation of soluble silica	Clay; Soluble material
OLIGOCLASE (feldspar)	$3Na_2O$, CaO	Goes into solution as carbonate, chloride, etc.	Soluble material
	$4Al_2O_3$, $2SiO_2$	Forms carbonate, which is soluble in water containing CO_2	Soluble material
		Decomposes	Clay
MUSCOVITE (mica)	$2H_2O$, K_2O, $3Al_2O_3$, $6SiO_2$	Remains undecomposed	Mica flakes
	H_2O		Water
	K_2O	Goes into solution as carbonate or chloride	Soluble material
BIOTITE (mica)	$2(Mg,Fe)O$	Goes into solution as carbonate or chloride; iron carbonate oxidizes to hematite or limonite	Soluble material
	Al_2O_3, $3SiO_2$	Forms hydrous Al. silicate and soluble silica	Clay; Soluble material
ZIRCON	ZrO_2, SiO_2	Remains unaltered	Zircon grains
Apatite	$Ca_3(PO_4)_2$, (F,Cl)	Is soluble	Soluble material

Fig. 6—Tabulation Showing the Effect of Weathering Upon the Minerals Found in a Granite (After Tyrrell)

minerals undergo alteration in some manner or another. The feldspars change into clay, the peridotites change into serpentine, the micas are altered, and even the quartz (SiO_2) is not unchanged. The following tabulation from Clarke's Data of Geochemistry shows the alterations from sound to decomposed rock. Only the essential constituents, however, are given.

	Mica granite		*—Diabase—*		*—Diorite—*	
	Fresh	Altered	Fresh	Altered	Fresh	Altered
SiO_2	69.33	66.82	47.28	44.44	46.75	42.44
Al_2O_3	14.33	15.62	20.22	23.19	17.61	25.51
Fe_2O_3	...	1.88	3.66 }	}	}	}
FeO	3.60	1.69	8.89 }	12.70 }	16.79 }	19.20
MgO	2.44	2.76	3.17	2.82	5.12	0.21
CaO	3.21	3.13	7.09	6.03	9.46	0.37
Na_2O	2.70	2.58	3.94	3.93	2.56	0.56
Ignition	1.22	3.27	2.73	3.73	0.92	10.96

With respect to physical properties of road-building rock, the change brought about by weathering is also noticeable. The weathered rock offers less resistance to impact and abrasive action, as shown by the following results, taken from Miscellaneous Publication number 76, United States Department of Agriculture:

Item	(A) *—Quartzite—*		(B) *—Granite—*		(C) *——Chert——*	
	New	Weathered	New	Weathered	New	Weathered
Per cent of wear	2.0	2.4	2.8	3.6	6.3	7.4
Toughness	16	18	9	7	5	...
Per cent absorption	0.20	0.25	0.71	0.29	2.91	1.72
Weight per cubic foot	175	172	168	168	153	159

Application to Highway Construction

Upon exposure to the air, for a sufficient length of time, all rocks undergo disintegration, and are finally altered into a mixture of soil composed essentially of sand grains, clay, etc. If the elements (ice, rain, water, etc.) are not too active this layer of soil will overlay the hard rock into which it grades. Rock weathering is of fundamental importance to highway construction, inasmuch as it affects the ultimate life of concrete structures, and/or pavement surfaces. Here the engineer is concerned with the selection of suitable material for his purpose. He should have knowledge of the results caused by rock weathering, and the probable effect when such rock is used in construction work.

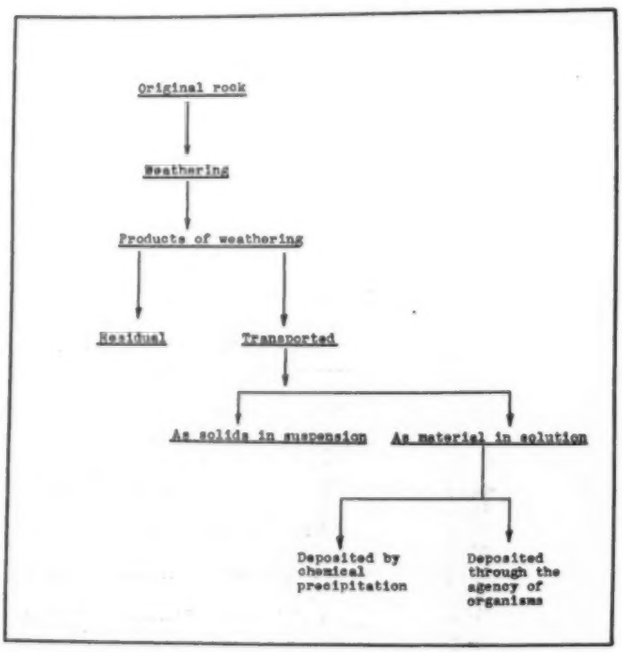


Fig. 7—A Schematic Diagram Showing the Distribution of the Products of Weathering (After Tyrrell)

Fig. 8—Quarry Debris. Here the Rock Fragments May Be Examined for Signs of Decay

In order to gain some knowledge of the weathering characteristics of a rock, the exposed ledges should be examined for signs of weakness. Any discoloration in the rock face might be interpreted as the beginning of decay. Such an examination should also include all the strata intended to be used in any proposed quarrying operation. Quite often rocks that appear sound in newly opened quarries will "rot" upon short exposures to the atmosphere. Consideration should also be given to the quarry debris, that has been exposed to the weather for some time. Here it is possible to learn something of the expected durability of the rock.

There are at present a number of laboratory tests employed to determine the suitability of rock for construction purposes. These tests are, (1) freezing and thawing, and (2) the accelerated soundness test, using a magnesium or a sodium sulphate solution. In addition, a petrographic study of thin sections of rock is also used to a limited extent. By this means it is possible to learn whether or not any minerals of known poor durability are present in the rock.

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Blading Surface of Runway

PAVING RUNWAYS AT AIRPORT SAVANNAH, GA.

By GEO. E. MARTIN

Consulting Engineer, General Tarvia Department, The Barrett Co., New York

THE city of Savannah has long been an important transportation center. Rail and steamship lines have been prominent factors in the life of the city for many years. It was natural, therefore, for the new transportation medium, the air line, to select Savannah as one of the key cities in its network. Several years ago the city obtained an area for an airport. The site was exceptionally well selected in that it is possible to land easily on the field without having to dodge obstructions, and the port is comparatively close to the center of the city.

The field had been filled and leveled, and a sodded all-way landing area maintained. However, the sod did not thrive very well. The grass grew in bunches while the wind removed the soil between the patches of sod. As a result the landing field became rough and unsatisfactory.

Early this year the city received a P.W.A. grant of $110,000 for cleaning, grading, and draining the area and the construction of a steel and concrete hangar and bituminous runways. This work is now under way as a co-operative project between the city and the W.P.A.

Grading and drainage were the first parts of the work to be done.

The drainage system consisted of pipe lines on each side of the proposed runways with proper man-hole connections. Concrete pipe was installed and satisfactory inlets provided so that the field will be thoroughly drained. The surface water is led through the pipes to low ground where it will do no harm. The sandy nature of the soil made necessary the use of rather heavy timbering to support the sides of the drainage trenches during construction. The drainage system was completed prior to the construction of the paved runways.

The Runways

Two runways, each 3,000 ft. long by 125 ft. wide, were selected for paving. The runways intersect and are laid out so as to take advantage of the prevailing winds. The necessary connection between the runways and the new hangar is also to be paved. This connecting way was originally planned to be 75 ft. wide but may be widened.

The soil in the runway area was disced and harrowed so as to loosen the old sod and thoroughly break the surface. The loosened sod and other vegetable matter was then removed from the soil by means of hand rakes and carted away. This somewhat tedious operation was necessary to prepare the soil for further treatment.

Spreading the Tar

The surface was then graded to a true contour and cross section by means of blade graders. Additional soil was added where necessary. The surface of the runway was loosened to a depth of about 8 in. by means of plows and harrows and graded into shape.

A typical sieve analysis of the soil is as follows:

	Per Cent
Passing # 10 sieve, retained on # 40 sieve..	2.5
Passing # 40 sieve, retained on # 80 sieve..	36.0
Passing # 80 sieve, retained on #100 sieve..	29.8
Passing #100 sieve, retained on #200 sieve..	26.2
Passing #200 sieve	5.5
Total	100.0

On the basis of this information it was decided to bind the soil with bituminous material and construct the paved runway by the mixed-in-place method.

Runway Paving Operations

Tar meeting the Georgia State Highway specifications for material TSB-1 was selected for the binder. This tar has a specific viscosity, Engler, at 60°C of 16 to 32 and the material actually used has had a specific viscosity in the vicinity of 25.

The tar was heated to approximately 175°F and shipped in tank cars from The Barrett Company storage plant in Savannah to a siding near the job.

The tar was applied by means of an Etnyre pressure distributor, owned and operated by the city of Savannah.

After the runway area had been properly graded the tar was applied at the rate of ½ gal. per square yard. Mixing was started immediately with the disc harrow. The runway width was divided into six sections approximately 20 ft. wide, and each section was worked separately. The tar was applied over the entire width of the section at one time by the distributor.

Successive applications and mixing were carried on until about 1½ gal. per square yard had been placed on the top of the runway. The top 3 in. of the tar-sand mix was then bladed to the sides and slightly more than ½ gal. per square yard applied and mixed into the bottom 3 in. Some tar from the top had already penetrated into the bottom course. After this operation had been completed, the tar-sand mix in the side windrows was bladed back over the bottom section and further applications of tar and mixing resumed. The major portion of the mixing at this stage was done with a blade grader. A plank drag was used to assist in thoroughly mixing the tar and soil. The total tar required for the 6-in. depth averaged about 3 gal. per square yard.

Drainage System Under Construction

New Hangar under Construction

The surface was then bladed into shape and consolidated by rolling.

A final seal coat of approximately 0.2 gal. of tar per square yard with about 25 lb. per square yard of stone chip cover will complete the job.

The only building on the old airport was a small office and station used by the Eastern Air Transport. This is to be replaced by a modern steel and concrete hangar, providing for storage and repair of planes as well as station and office space.

By the proper utilization of existing local material it has been possible for the City of Savannah to obtain a modern, up-to-date airport for a moderate cost.

The Works Progress Administration work has been under the direction of Mr. R. V. Glenn, Assistant State Administrator of Atlanta, and Mr. D. G. Nichols, Local District Administrator, located at Savannah. Mr. M. G. Driskell has had direct charge of the runway construction for the WPA. Mr. A. S. Goebel, City Engineer, has represented the city of Savannah in the work at the airport.

Publication on Highway Bonds Available

Highway Bond Calculations, by Laurence I. Hewes and James W. Glover, has been published by the U. S. Department of Agriculture. This publication consists of selected sections of Department Bulletin 136, Highway Bonds, published in 1917, but now out of print.

Sinking-fund serial, and annuity bonds are described in detail and their relative merits are compared. Definitions of the terms involved are given, together with explanations and derivations of essential formulas. Examples of typical problems and their solutions are presented. Several tables to seven decimal places for 60 intervals and 14 interest rates are included, making it a publication convenient for reference.

Highway Bond Calculations may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 10c a copy.

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THE TECHNICAL SERVICE BUREAU of The Barrett Company invites your consultation with its technically trained staff, without cost or obligation. Address The Technical Service Bureau, The Barrett Company, 40 Rector Street, New York.

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BITUMINOUS MAINTENANCE IN SOUTH DAKOTA

By W. N. LOVEJOY and JOHN F. JACOBS

Construction Engineer and Maintenance Engineer
South Dakota State Highway Department

THE South Dakota Highway Commission started the construction of bituminous surfaced highways by contract and with federal funds in the spring of 1931. As is usually the case with new ventures, advisors were called in to tell us the best ways to build these low cost roads. The reason for mentioning this to begin with is that some of our worst maintenance problems were an outgrowth of that advice. The most disastrous advice was the following: Any gravel surface road that has successfully carried the traffic is suitable for a base course on which to construct a bituminous mat. We have approximately a hundred miles of this sort of construction which is a constant source of trouble. The principal cause is the lack of base thickness and poor sub-drainage which never showed its true nature until a tight bituminous cover was placed thereon. A few more sources of maintenance trouble were the use of an over-abundance of road oil in the mix, the lack of a sufficient quantity of filler in the mix, and it is remembered too that one advisor told us that when a lack of adequate filler confronted us, the proper thing to do was to increase the percentage of road oil and use a higher viscosity material. This fallacy was easily recognized the first time it was tried out.

Not all of the advice was bad, however; much of it was of value and is still being heeded—insist on good quality bitumens; dry the aggregate thoroughly before mixing bitumen into it, as moisture is the worst enemy to the stability of the mat; avoid aggregate having high shrinkage properties. Lean mixes are more stable than rich mixes and it is easier to cure raveling than it is to correct corrugating—not that we haven't had some of the latter, but we have kept it to a minimum. It is much easier to put heavy penetration seal courses on lean mats than it is to scarify and add more aggregate to overly rich mixes, and too, it has always seemed to us that rich mixtures invite moisture trouble by suction from below.

866 Miles Bituminous Surfacing Constructed

At this point it might be well to give a statement of how much bituminous type highway mileage South Dakota has, and I will endeavor to make this resume as accurate as possible.

	Miles
During and prior to the year 1931 there was constructed a total of	154.051
During the year 1932 there was constructed	156.174
During the year 1933 there was constructed	90.588
During the year 1934 there was constructed	139.004
During the year 1935 there was constructed	109.449
During the year 1936 there is under construction and will probably be completed	186.817
Total	835.583
Besides this, the Bureau of Public Roads is building this year in the National Forests of South Dakota a total of	23.356
The Park Service has constructed in Wind Cave National Park	7.000
Making a grand total of	865.939

Note: This total does not include 100.0 miles of light surface treatment work which is being undertaken late this season as a dust palliative which will probably be followed next year with a substantial mat.

Classification by Types

This work can be classified by type as follows into five groups:

(1) Plant mix graded aggregate type, 3 in. mat thickness with slow curing and medium curing liquid asphalts, 145.7 miles; average cost approximately $6,000 per mile.

(2) Road mix graded aggregate type, 3 in. mat thickness with slow curing and medium curing liquid asphalts, 507.2 miles; average cost approximately $5,200 per mile.

(3) Road mix graded aggregate type 1 in. mat thickness with slow curing and medium curing liquid asphalt, 92.1 miles; average cost approximately $3,300 per mile.

(4) Retread macadam aggregate type with rapid curing liquid asphalt, 2 in. mat, 76.7 miles; average cost approximately $5,500 per mile.

(5) Retread macadam aggregate type with medium viscosity refined coal tar, 2 in. mat thickness, 44.2 miles; average cost $5,425 per mile.

Summing up the five groups, we have a total of 865.9 miles which is located in 45 of the 64 counties of the state. The average construction cost per mile of all types has been approximately $4,000 per mile. Unfortunately, this mileage is badly scattered over the state on account of the laws and policies governing apportionment of highway funds. Public sentiment is crystallizing into a determination to get at least one dustless highway across the state east, and west within the near future, a distance of approximately 440 miles. This will have to be accomplished in order to keep and regain tourist travel in the state.

How Maintenance Is Handled

General highway maintenance in South Dakota is handled in that rather unsatisfactory manner of having the separate county highway organizations do the work and then receive reimbursement from state highway funds. Our legislatures during the last sixteen years have been very "county-minded," giving 80 per cent of our funds from vehicle license taxes directly to the

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counties, and the worst misfortune was the necessity of using half of our 4ct gasoline tax to retire state bonds in no way connected with highways. This all tends to hamper our getting a centralized maintenance department, but we have made a determined effort from the start to keep bituminous maintenance within the state highway department and not let each county dabble in it.

The state is divided into five highway districts and each district engineer is responsible for the maintenance of the state highways in his district. During the last two years we have set up full-time bituminous maintenance crews in each district, equipping them with kettles (and of courst trucks), etc., having power-driven, hand-operated spray jets and short length spray bars. These units vary in size from 160 gal. to 600 gal. These crews do all the necessary repair work, from scarifying to sealing, and we now believe that it is much better to be on the job continuously with small units than to wait for a big outfit to move in when major difficulties have arisen. Our earlier decision was to have one large maintenance outfit somewhat similar to a contractor's organization and make the "rounds" from project to project as occasion required and convenience permitted. We found this to be a rather unsatisfactory and cumbersome arrangement and are now using the large outfit only for construction and reconstruction work on the early constructed projects.

No definite number of miles can be assigned to a maintenance outfit; the necessities of the work must govern. Some projects require very little maintenance and others are forever needing attention. Probably an average of 60 miles will be found to be about the proper length to assign to an outfit.

At present we are operating ten small outfits on a more or less full-time schedule. Each outfit has a personnel of approximately five men, and their equipment consists of a 1½ to 2 ton truck, a kettle, small tools, a roller and power patrol with scarifier.

Winter maintenance is also carried on to a large extent. Fortunately, bituminous mats do not need so much attention in the winter season. Freezing may cause bulges and heaving in a few instances, but for the most part there is an added stability present during the winter months. However, with the coming of spring, wet snow and the departure of frost from the ground, the worst conditions of the year must be met. During the winter season, provided there isn't too much snow, the contraction cracks are filled with bituminous material and dried warmed sand. A determined effort is made to keep melting snow off the mat. Nothing soaks up the edges and shoulders more disastrously than snow allowed to melt on the edges of the road.

Maintenance Methods

At the risk of being somewhat trite I will describe the performance of what is probably the most common maintenance work, namely, repairing the breaks in the edges of the mat. Repairs to the outer third of the mat occasions more work than all the rest of the road by far. Where traffic has broken down the shoulder support and a definite breakup and sag has occurred, the men dig out the failed area using care to pile separately the failed bituminous treated aggregate so it can be salvaged and taken to a stock pile and eventually worked into scarified areas. The area is laid out as nearly rectangular as possible and the edges are cut vertical and not just any old way, and the excavating is carried down far enough to get to a solid support. All the soft excavated material which failed to "stand up" is removed and wasted. The hole is next filled with oversize gravel to within about two or three inches of the top and thoroughly tamped. There is also a lead out "French" drain put in to insure against a recurrence of the trapped moisture which is the usual cause of the failure. The tamped backfille and edges are next painted lightly with bituminous material, usually with RC-1, and the stockpiled material of the same nature as the mat is then filled into the top portion of the hole in layers slightly overfilling it and is then tamped into place, after which it is again opened to traffic. We have been experimenting recently with the idea of placing permanent lumber edge forms for repairing weak shoulder areas and we believe it will be worth while. Far too many maintenance men treat the bituminous stock pile material, which costs about $3.76 per cubic yard, in much the same manner as patch gravel on gravel surfacing. The difficulty seems to be to educate these men to differentiate between a patch and a repair. After the repaired area has been under traffic for a week or more it is again examined for defects and then sealed with RC-1 and screened sand, and should be just as good as the rest of the mat.

Our stock piles are made up at the same time the project is constructed. Gravel and filler are mixed and dried on a side road with motor patrols and road oil, usually SC-5, is mixed into the aggregate windrow in a slightly higher percentage than used in the mat. The mix is placed in a compact well shaped pile in a high and dry location. It has been customary to estimate the stock pile needs at the rate of 35 cubic yards per mile of project, but there seems to be no correct ratio, either it is entirely too much or not enough.

This season we have been using quite a good deal of MC-3 in road mix and MC-4 in plant mix, and I have been rather doubtful about putting up any very large stock piles for fear they would harden in a year or so.

Maintenance Problems in Gumbo Soil

Last year we listened to a speaker at this meeting tell us about a soil he called adobe and the difficulties encountered in maintaining a bituminous mat on top of it. I believe we have a soil covering most of the western half of South Dakota which is fully as bad but we call it gumbo. It is disintegrated shale, which is an A-6 to A-7 soil, and it is very plastic and unstable material when wet and cracks badly when dry. It also has cumulative properties toward water and never lets it go, and the cuts section are usually worse than the fill sections with this type of soil. We haven't effected any definite cure for our maintenance troubles in gumbo, but we have alleviated them somewhat by thickening the edges of the mat and putting in "French" drains at every soft place in the shoulder and then rolling the edges at regular intervals with a heavy pull roller. New work is being put down with a thicker base course. Mats laid on gumbo seem to lose their life in about three years, and last fall and this summer we have been reworking some of the oil surface mats laid in 1931 and 1932. We have had to add almost as much road oil as we put in originally. This reworking of 1,000 cubic yards per mile mats has cost us about $1,800 per mile and we are making the experiment of putting in a layer of coarser rock and road oil as a sort of base course lift, hoping that we can break up the emulsification action which gumbo seems to cause.

In the eastern part of South Dakota where the soil is more granular we have had much better success with oil mix mats, and except for a few spots where ground

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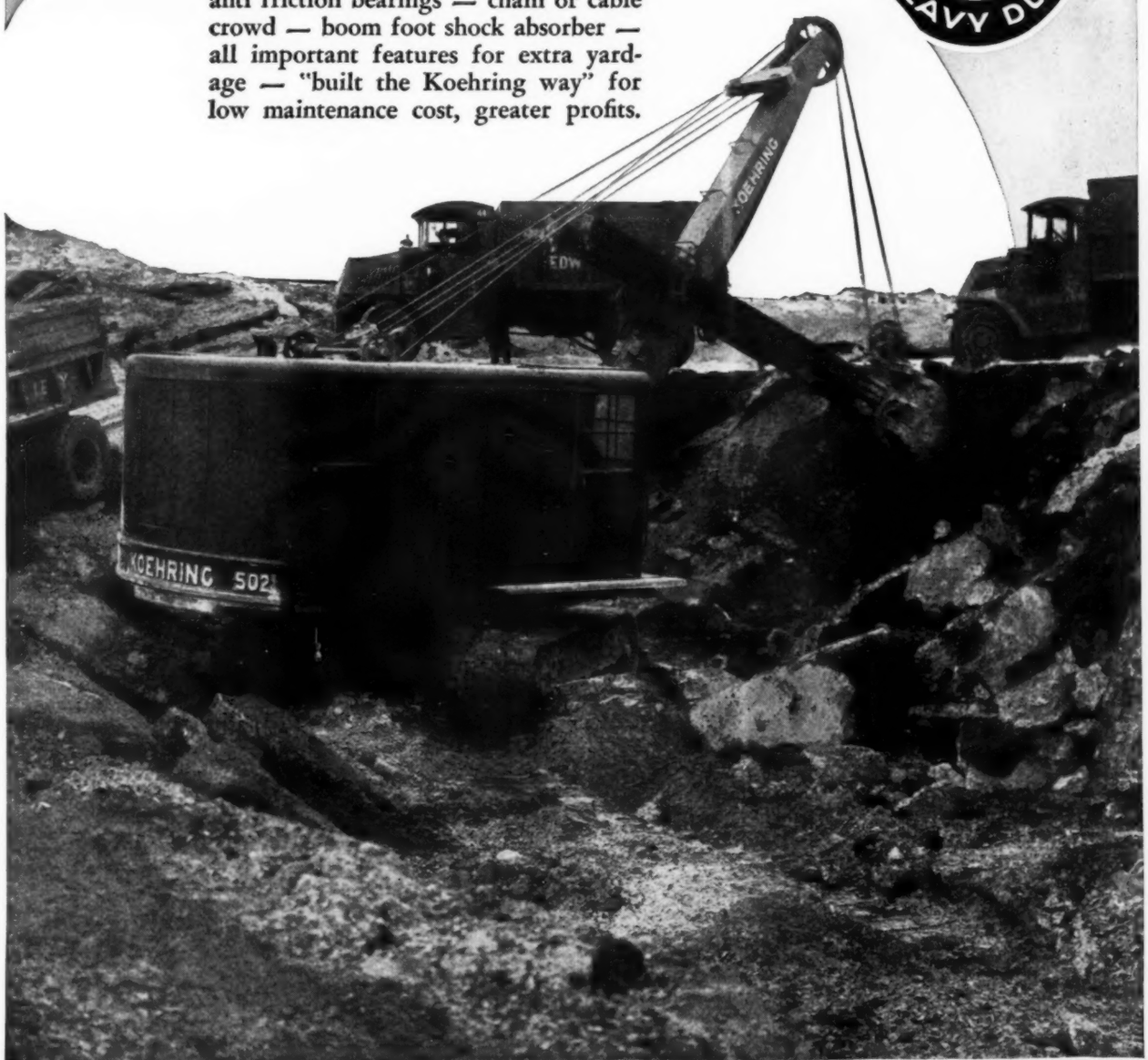
KOEHRING HEAVY DUTY



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water hasn't been properly handled, maintenance has not been excessive in cost.

This year we have let by contract about 100 miles of seal coat work on several projects that have been down three years or more. The cost has been approximately $290 per mile, including 2,500 gal. of RC-1 and 25 cubic yards of screened sand. This has been a fully satisfactory procedure and will probably be continued.

Maintenance is not an easy thing to describe and outline. There is always something different developing and eternal vigilance is the best plan of action.

It is realized that traffic census and soil surveys are a great help both in designing a project and forecasting maintenance costs. At present we do not have either, but it is hoped and expected that the State-wide Highway Planning Survey now in progress will furnish us both of these at some future date.

Maintenance Costs

An analysis of maintenance costs in South Dakota will be made in conclusion. We have figures compiled only for the years 1933, 1934, and 1935. The total maintenance cost per mile per year for 1933 was $166.82; for 1934, $264.49; and for 1935, $282.36; an average for the three year period was $246.78 per mile per year, which it is believed will be close to the 1936 figure. Several expensive reseals and retreatments were paid for in 1934 and 1935 out of maintenance funds which should really be counted as construction. These amounts given include all the yearly charges against the project and are not alone bituminous surface repairs.

It might be well to give a statement as to just how the different types fared in maintenance cost per mile per year over the three year period.

Type 1—Plant mix graded aggregate type, 3 in. mat, $131.07 per mile per year.

Type 2—Road mix graded aggregate type, 3 in. mat, $212.27 per mile per year.

Type 3—Road mix graded aggregate type, 1 in. mat, $222.46 per mile per year.

Type 4—Retread macadam aggregate type (rapid curing cut-back asphalt) 2 in. mat, $456.73 per mile per year.

Type 5—Retread macadam aggregate type (medium tar) 2 in. mat, $546.53 per mile per year.

The predominating advantage in favor of the plant mix type is due in part to merit and in part to good luck with the comparatively small mileage. The predominating disadvantage at which the two macadam aggregate types appear is due in large part to the heavy traffic they are subjected to and the expensive retreatments which were charged against maintenance. It is believed another year will see a more equitable adjustment. Types 2 and 3 show more truly the average cost of yearly maintenance as they include nearly 600 miles out of the 866 mile total mileage, or approximately 70 per cent.

A breakdown of the 1934 figure of $264.49 cost per mile per year maintenance cost shows $47.75 charged to a miscellany of items, including cleaning ditches, removing snow, etc., all of which is chargeable to any type surface. The strictly bituminous items are $183.73 repairing surface and $33.01 to stock piles. A breakdown of the 1935 figure of $282.36 cost per mile per year maintenance cost shows $86.40 charged to a miscellany of items including cleaning ditches, removing snow, etc. The strictly bituminous items are $174.39 repairing surface and $21.57 for stock piles. The bituminous maintenance in 1935 really shows a decrease over 1934, and with a better understanding gained by experience we trust will enable us to improve the record as we go along. Acknowledgment—The foregoing is a paper presented at the second annual Montana Bituminous Conference held September 8-10 at Glacier National Park.

▼

Crane With 100-Ft. Boom Used in Erecting Masonry

A crane, having a 100-ft. alloy steel gooseneck boom, was used by F. W. Owens, Contractor, Louisville, Ky., for handling the stone for the construction of the Sts.

Construction View at St. Peter and Paul Cathedral, Indianapolis, Ind.

Peter and Paul Cathedral at Indianapolis, Ind. This machine lifted and placed three blocks, each weighing 20 tons. The blocks lifted by the machine were hoisted 60 ft. above the sidewalk. Practically all the stone used on this job were handled by this Lima crane. For the heavy lifts a 6-part line was used; for the lighter loads, such as brick, mortar and small stones the single line was used.

▼

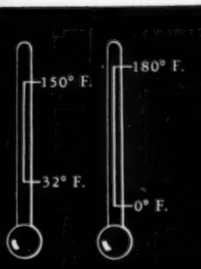
CITY STREET MILEAGE—An analysis made by the National Highway Users Conference recently from data submitted by the American Road Builders Association and other sources gives the following information concerning city street mileage and population:

Cities having a population of	Number of cities	Population	Street mileage
100,000 and over	93	36,325,736	65,870
50,000 to 100,000	98	6,491,448	16,610
30,000 to 50,000	121	4,733,354	13,160
5,000 to 30,000	1,521	16,686,695	75,400
2,500 to 5,000	1,332	4,717,590	21,050
Total	3,165	68,954,823	192,090

Asbestos Bonding

WINS ANOTHER BIG SEWER JOB

Installing an *Asbestos Bonded* Armco Paved Invert sewer in a leading midwestern city. More than 1500 feet of 36-inch diameter pipe was used on this particular job.



Besides assuring permanently tight adhesion *Asbestos Bonding* actually widens the plastic range of the bituminous coating and pavement —as much as 50 per cent.

WHEN Armco first introduced Paved Invert Pipe with *Asbestos Bonding*, municipal engineers immediately recognized its possibilities. As a result, scores of installations are now in progress or planned for sewer and drainage purposes.

This sudden trend to *Asbestos Bonded* pipe is easy to understand when you consider these facts: After more than a quarter-century of service, many Armco corrugated iron sewers look good for at least another 20 years. Remember, too, that these veteran Armco Ingot Iron structures are all plain galvanized pipe—unpaved and uncoated! Putting a special *smooth* bituminous pavement in the bottom (where the wear comes) has already added 10 years to the life of this pipe. Now, with the addition of a complete bituminous coating . . . inseparably "bonded" to the pipe by means of asbestos fibres . . . it is obvious that a high degree of permanence is assured.

But that's only part of the story. You'll find more facts about this greatly improved sewer pipe in our new 12-page bulletin. Mail the coupon for your free copy. Armco Culvert Mfrs. Association, Middletown, Ohio.

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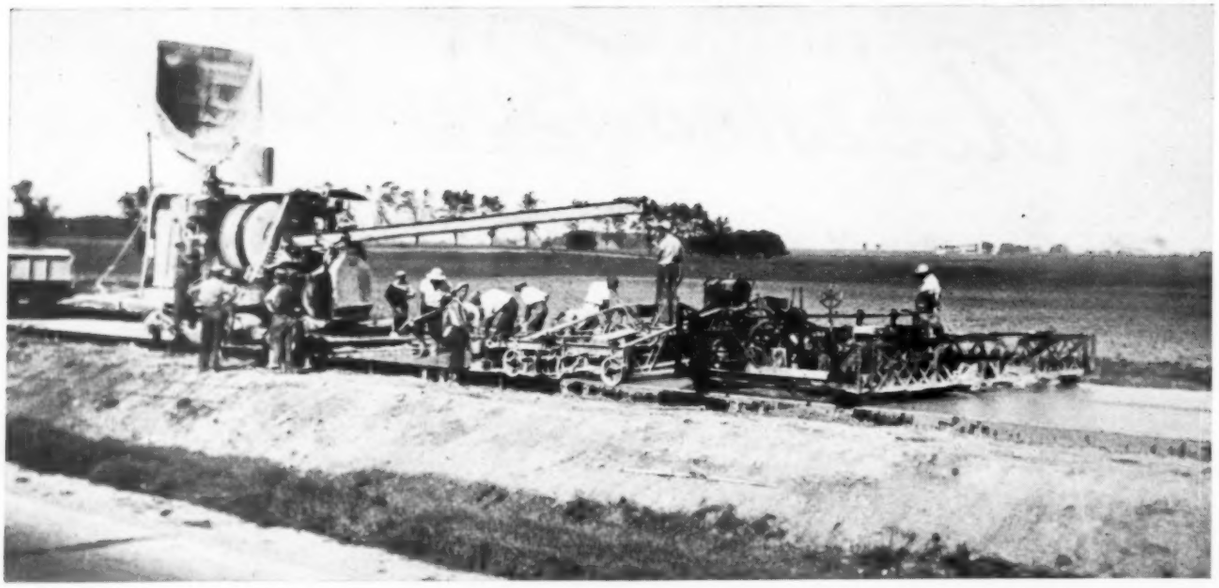

Griffith's Outfit on the Road. The Mixer Is Followed by Two Strike Boards, a Transverse Finishing Machine, a Joint Finishing Machine and the Longitudinal Finisher or "Bull Float." The Latter Is Not Shown in This View

LONGITUDINAL FINISHING MACHINE LESSENS LABOR

TRAFFIC on the present highway U. S. 41, between Milwaukee and Chicago, is too heavy for convenient travel. To alleviate the situation a new 4-lane road with a parkway in the center is under construction. It will probably be completed next year. The road traverses Cook and Lake Counties in Illinois and Kenosha, Racine and Milwaukee Counties in Wisconsin. In driving over this new work, all of which is reinforced portland cement concrete, two new units of equipment were noticed.

One was a subgrader. It was not working, so no pictures were taken. The other was a new type of finishing machine. This machine, a Koehring product, is the last unit of equipment used to finish the surface of the slab. Two views of it are shown in the accompanying pictures. It follows behind the work of the machinery shown by the mixer in the other picture. When the concrete is poured, it is struck off by a strike at the place where the welded reinforcing mesh is placed. Then the rest of the slab is poured and struck off. The next unit of equipment is a transverse finishing machine. This is followed by a joint machine, then after a few minutes for setting and settlement the new "bull float" finishing unit works the surface lengthwise of the pavement. The Koehring finisher or "bull float" moves forward at the same time that the float or finishing bar moves across the pavement. Finishers with 10-ft. straight edges follow the machine and it was noticed that there was not more than ⅛-in. variation in the 10 ft. and that only occasionally. The cement finishers were very well pleased with results of the machine. All they did was check the slab with the straight edge and finish the joints and edge. No belting or brooming followed the "bull float."

Full View of Koehring Finishing Machine. Operator Is Pushing Excess Mortar Ahead

View of the Float Bar As It See-Sawed Across the Slab. The Bar Runs Longitudinally With the Pavement

As the float see-sawed across the slab, it pushed a little laitance and mortar along. The man tending the machine kept this to an amount needed to leave a smooth mortar surface behind; the excess he pushed away ahead of the machine with a spading hoe.

F. R. Griffith Co. of Racine, Wis., are the contractors on the job.

LOWER CONSTRUCTION COSTS
GREATER STRENGTH AND BEAUTY

When you use American Sectional Plates

THE many uses to which American Sectional Plates are adapted will make it well worth your while to investigate this material when you are planning Culvert or Arch construction. You will find that drainage projects will cost less and take less time to build when American Sectional Plates are used. The completed installation will readily blend with the surroundings, will contribute to an attractive appearance.

Although the initial cost is lower when American Sectional Plates are employed, further worthwhile savings come from the ease and speed in their erection. These plates are constructed so that they literally "fall together." Any type of labor can assemble them quickly and easily.

A few of their other numerous advantages are in the simplification of planning, ease of transportation and the complete elimination of the danger of breakage.

For small bridges, all types of sewers, for enclosing small streams, for conduits, for safety underpasses, for replacement of unsafe or damaged structure and other similar uses*, be sure to investigate further the advantages of American Sectional Plates for Arches and Culvert Pipe.

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Tennessee Coal, Iron & Railroad Company, *Birmingham*

UNITED STATES STEEL

Hot Mixed Asphalt Surfacing Used on Tennis Courts at Trenton, N. J.

By R. C. HEATH

Manager, Street and Road Department
The Barber Asphalt Co.

THIRTY-FIVE asphalt-surfaced tennis courts have just been completed in different playground areas in Trenton, N. J.

With the completion of these courts, Trenton will join the long list of cities in California and other states throughout the country which have taken the initial step to eliminate future expense of maintaining clay tennis courts.

Director of Public Works and Service, Jos. E. English of Trenton, N. J., who planned the new asphalt tennis courts, decided to use hot mixed asphalt surfacing, similar to that used on important sheet asphalt thoroughfares, a type of surfacing which has proved to be one of the smoothest and most desirable for tennis courts.

This type of tennis court, according to engineers, playground and recreation center superintendents, is perhaps the most satisfactory for several reasons. In the first place it is resilient, a quality of special importance when court areas are used by players for long periods. Asphalt surfaced courts are not only clean, but free from dust. They are firm, which makes for a fast game. Asphalt tennis courts have the further advantage of being durable, smooth, easy to repair and non-glaring. Because they dry rapidly, asphalt surfaced courts are ready for use a short time after a rain.

The excavating and foundation for the tennis courts was done by WPA labor under the direction of P. N. Daniels, Federal Works Projects Engineer for the City of Trenton. A foundation consisting of 4-in. waterbound macadam was laid by WPA labor and then rolled.

The Union Paving Co. of Philadelphia, Pa., was awarded the contract for mixing and laying the binder and wearing surfaces on these courts at a price of $1.59 per square yard; and the mixtures were made at the Union Paving Co.'s plant in Trenton, assuring a more uniform quality of the mixtures than if they had been prepared on the different jobs at various times.

Inspection of the bituminous mixtures used for the binder and wearing surface was made under the direct supervision of L. D. Long of the Jersey Testing Laboratories, 101 High Street, Newark, N. J.

A binder course consisting of crushed stone, sand and Trinidad Lake asphalt cement was mixed hot, hauled to the job and compacted to a thickness of 1½ in. A wearing surface composed of sand, crushed stone and stone dust made with Trinidad Lake asphalt cement of 60 to 70 penetration was also mixed hot, hauled to the job and compacted to a thickness of 1¼ in. with heavy rollers until the wearing surface was absolutely level.

Twenty-three thousand, seven hundred and six square yards of surfacing was done on the 35 courts in the five different playground areas throughout the city. The largest number of courts was installed at the Trenton High School Athletic Field, Hamilton Avenue and High School Drive. Here 15 courts were constructed, having a total area of 10,666 square yards.

Nine courts, with a total area of 5,750 square yards, were constructed in Cadwalader Park, Parkside Avenue and the Feeder, located in the northern part of the city.

Rolling Wearing Surface of Tennis Court in Stadium Playground, Sweets Ave. and Reservoir St., Trenton, N. J. The Triangular Section of the Court at the Right of the Picture Shows the Binder Course, While the Middle Black Section Shows the Appearance of the Wearing Surface Before Being Rolled

At Lamberton Park, located at the foot of Landing Street, Delaware River, and Chestnut Park, Chestnut Avenue and Division Street, four courts were built, having respective areas of 2,560 and 2,640 sq. yds.

Three asphalt-surfaced tennis courts containing an area of 2,000 sq. yds. were also constructed at Stadium Playground, Sweets Avenue and Reservoir Street, in Trenton.

Hot dip, after forming, galvanized iron fencing, ranging from 10 ft. to 12 ft. in height, was used at the ends, sides and partitions of the courts. Iron posts fitted with ratchets, which make for ease of tightening nets, were used on all the tennis courts.

World's Longest Stretch of Sodium Lighting Installed

The longest single stretch of sodium highway lighting in the world, extending approximately 18 miles over Route 7 leading into the city of Schenectady, N. Y., was placed in operation on the evening of Sept. 18. In addition, the first commercial installation of a new safety-lighting system designed by General Electric engineers was inaugurated on over five miles of the Balltown road, a north and south highway east of Schenectady. With the completion of these installations, all main highways entering Schenectady county are illuminated. The county now has approximately 60 miles of highway lighting in operation.

A total of 391 G-E 10,000-lumen sodium units are installed along the 18-mile section of Route 7. The luminaires are mounted about 250 ft. apart on alternate sides of the road, except on curves where they are placed on the outside.

The 231 incandescent luminaires on the Balltown road are of special design and use the new 400-candlepower tubular half-inch bar filament incandescent lamps. These lights are staggered 125 feet apart along the highway.

This 18-mile installation of sodium surpasses in length the stretch of golden light for the San Francisco-Oakland Bay bridge, which will also be in operation this fall. The latter, however, will employ over 900 units on the upper and lower decks of the span.

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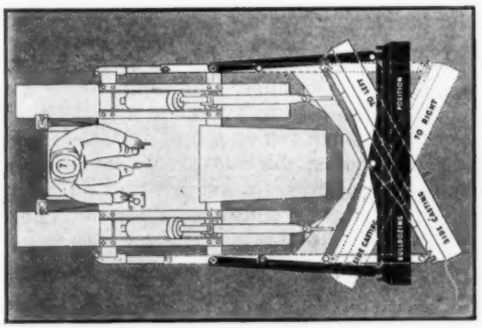
PROTECT YOUR TRACTORS

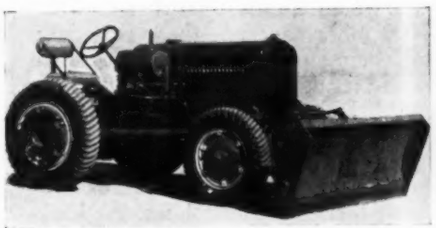
Outstanding among the many advantages of Gar Wood Roadbuilders and Bulldozers, is the method of mounting the attachments, which saves a great deal of wear and tear on the tractor.

All actions of the hydraulic hoists are self-contained within the attachment members and transferred directly to the ground through the rugged side frames of the tractor. The body of the tractor is not used as a counterbalance for either attachment, so there is no abuse to transmission and clutch housings. No shocks or strains can be transmitted to any moving axle or driving shaft. No eccentric loading. The drawbar of the tractor is left free for drawn tools. Send for complete details of these ingenious, dependable Gar Wood aids to roadbuilders.

They're built to take plenty of punishment in any kind of going, with no abuse of the tractor.



Roadbuilder blade can be set for right or left side casting positions, as well as bulldozing position.



Light, fast working, and efficient cross-walk snow plow attachment, hydraulically operated blade.

Hydraulic "dig-carry-dump" scraper, built in 6 to 12 yard capacities. Efficient in any soil conditions.

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GAR WOOD INDUSTRIES, INC.

DETROIT, MICHIGAN

Observations by the Way

By A. PUDDLE JUMPER

¶ A lot of improved signing is needed in and around the industrial areas just south of Chicago. At many points where signs could be most expected there are none, and it takes a clairvoyant to follow an unfamiliar route.

• •

¶ Canadians are noted for their courtesy, but the most discourteously (or perhaps merely the dumbest) driven car I have seen this year bore an Ontario license.

Let's omit the horrible details, and certainly let us not allow one boor to lower our esteem of good neighbors; right now we can think of several morons who are driving Illinois licenses.

• •

¶ Milwaukee handles its downtown intersection traffic smoothly. Just a simple system of one whistle to stop —a pause of about five seconds— then two whistles to start on the other street; but it works beautifully. Drivers more promptly and together, nobody tries to beat the whistle, and the pedestrian gets a practical break.

• •

¶ Cuyahoga County, Ohio, and the Ohio State Highway Department have done such a nice job of providing easy access highways to Cleveland's city limits that it seems like the city should continue the good work. It takes so long to get into the business center, except from the West, that the man on business gets irked at the time he loses getting *through* traffic.

• •

¶ What can we do about the slow driver on a crowded two lane road?

• •

¶ Information has just come to me that on a black top job in the south a roller equipped with the third roller finished the surface with less than 1/8 in. variation in 10 feet.

• •

¶ That "bull float" for finishing concrete paving that I saw on a job near Racine, Wis., was certainly well liked by the finishing crew. They spoke highly of its performance. It looked to me like the float should be longer, but that's an opinion I formed from watching it operate over only three or four hundred feet.

¶ Typical of the bridges being replaced by the highway program in Mississippi. There were many

Bridges Like This Are Being Replaced in the Mississippi Highway Program

bridges like this one. The new structures are designed and being constructed by a high standard of engineering.

• •

¶ My respects and regards to the drivers of those big common carrier trucks. I made it a point to check up on dimming of lights on approach and on keeping well to the right. In two whole nights of driving—over 1,000 miles covered—there was only one common carrier truck that failed to dim its lights and none hogged the road. I could not say so much for a few privately-owned trucks. The real offenders of night driving on our highways are the drivers of privately-owned automobiles. They have not learned the "Courtesy of the Road." "Courtesy of the Road" is a definite thing that has grown up with motor driving. Many common carrier trucks leaned backwards in their efforts to light the vehicle with red and green lights. Keep up the courtesies—truck drivers—I have no fears when meeting or passing you on the highway.

¶ Another thing "this country needs" is a wide highway from Chicago to a point between New York and Philadelphia, via the outskirts of Toledo, Cleveland and Erie, or the outskirts of Toledo, Cleveland, Youngstown and Pittsburgh, like the one under construction from Milwaukee to Chicago. The minimum allowable speed should be 40 miles per hour. This road should tie up with one from Boston to Washington, D. C. The federal government should finance these roads and keep trucks off.

• •

¶ Traveling on Highway U. S. 20 from a point east of Erie, Pa., to Cleveland, Ohio, is a first class pain in the neck. There is entirely too much traffic on the road.

• •

¶ We understand that contractors have been evading the state tax on sand and gravel shipments in Mississippi by having same shipped to them in care of the State Highway Commission. The director stopped it, though.

• •

¶ When those little trees grow up along that stretch of concrete road in Missouri north of Hannibal toward Quincy, Ill., there will be many miles of pretty driving.

• •

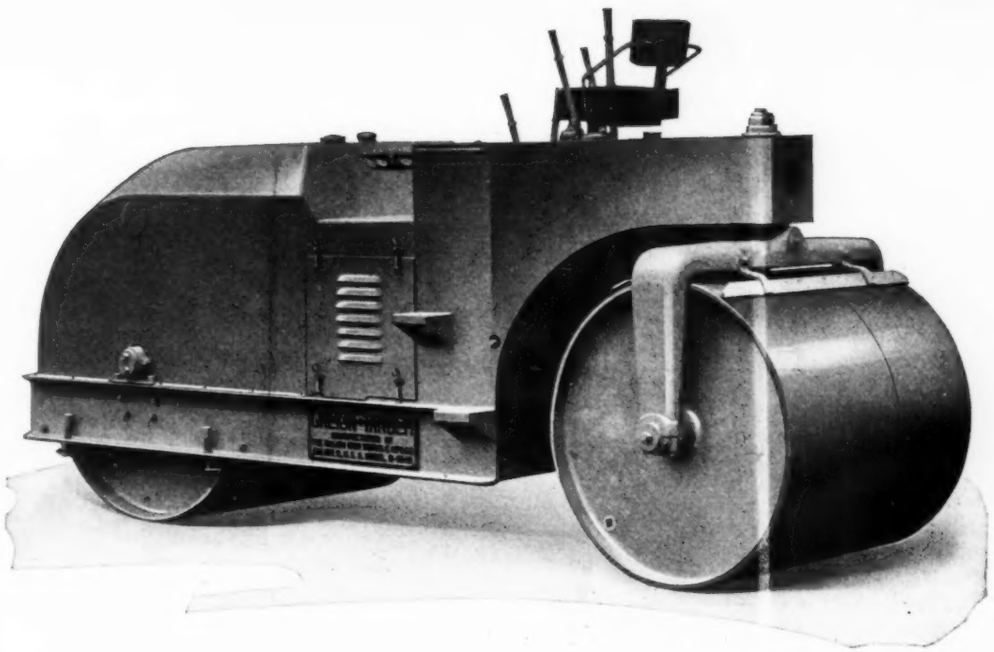
¶ Iowa has done a pretty good job of missing the business sections of most towns in the state with her new concrete road system. Eastern states, please note.

• •

¶ Those steel superstructure bridges on Highway 149 from Cedar Rapids to Amana, Iowa, present a nice appearance and I would guess are quite an economical design.

• •

¶ As I have stated before, what this country needs is a luminous traffic line paint. Last week in Washington, D. C., I inspected a center line that was painted with a white paint on which minute glass balls were stuck. The glass balls were bound by the body of the paint and held fast. The first night I visited this test piece it had been raining. The center line showed up hardly at all, no different than ordinary paint.



Left — The Galion Variable Weight Tandem Roller, the finest performing and easiest operating tandem roller ever offered.

Variable Weight Feature
Endorsed by Operators Everywhere

With this one inexpensive machine . . . the Galion "Variable Weight" Tandem Roller . . . the Road Builder and Paver can meet the various specifications and requirements of any job.

This variable weight feature provides in one compact, efficient unit the equivalent of a series of conventional tandem rollers from 7 to 10 tons in weight. No other roller possesses such desirable features as have been scientifically engineered into the new Galion design . . . a design which makes all other tandem rollers obsolete.

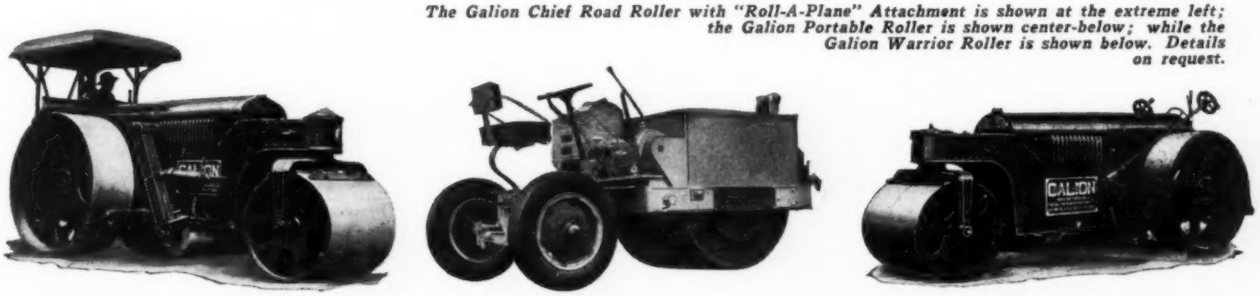
Powered by a reliable 6-cylinder gasoline engine, this modern Roller has the ability to go places and do things . . . to your complete satisfaction.

Let us send you literature covering this economical and practical Galion Roller. Write today.

● Distributors Everywhere

THE GALION IRON WORKS & MFG. CO.
Galion Ohio

The Galion Chief Road Roller with "Roll-A-Plane" Attachment is shown at the extreme left; the Galion Portable Roller is shown center-below; while the Galion Warrior Roller is shown below. Details on request.



However, the next night it was dry and the center line showed a good clear white. It was very easy to tell which parts of the line held the small glass balls and which was painted without application of the glass.

Later I talked to the man who invented and patented the idea. He is licensing paint manufacturers to make and sell the patented material.

• •

¶ Those town roads in New Hampshire are just wide enough for one car. Maybe that's enough in those hills. One wonders why cars go into the hills, anyhow.

• •

¶ Minnesota's legislators reduced vehicle license fees to such an extent that the highway department was unable to match federal funds. Then they turned around and authorized a bond issue for sufficient amount to make up for the cut in license fees. This bright stunt will cost the taxpayers of Minnesota about $4,000,000 extra. I guess such is the game of politics.

• •

¶ New York State has certainly done some excellent road building on Long Island. The Northern Parkway, Central Parkway, and Southern Parkway provide the means of recreation for the countless millions from New York City. The contractors and engineers who did the work should be awarded scrolls testifying to their excellent art and skill.

• •

¶ There was about $350,000 worth of construction equipment at work on that Middletown-Portland, Conn., bridge. Mr. Tripp, construction engineer for the contractor, says the company owns over $14,000,000 worth of equipment. Who can beat this?

• •

¶ "What this country needs" is a wide, fast road from Boston, around New York City to Washington, D. C., missing Baltimore and Philadelphia. Lanes of opposing traffic should be separated.

• •

¶ We congratulate Boston, Mass., and Suffolk County for the way they have made it possible for the traveler by motor to get quickly into the business district. Chicago please note.

• •

¶ Due to the fact that common carrier truck transportation has been placed under the regulation of the Interstate Commerce Commission the National Highway Planning Survey takes on added significance. Undoubtedly one of the primary missions of the survey will be to inventory and evaluate existing highways. These items can then be considered in the rate making structure for interstate motor transport.

• •

¶ The accompanying picture shows one of the type of signs placed all over the state of Pennsylvania. Each

Pennsylvania Safety Sign

sign has different wording and is so placed that it cannot be missed by the motorist. These signs should help reduce motor vehicle accidents.

• •

¶ Those paved roads in southern Iowa seem to be taken as a matter of course to Southern Iowans. Well do I remember the mud of pre-pavement days. I was more than glad that I was riding on good concrete paving during those heavy rains there.

• •

¶ Have you ever noticed how hard it is at night to read a wet sign? Especially if rain has just stopped falling and only a few drops keep striking the windshield? Reflectorized button signs can easily be read but not painted ones, no matter what the color.

• •

¶ These highway traffic and planning surveys will certainly produce information to show on what roads certain surfacings or improvements are economically justified.

• •

¶ West of Pittsburgh, Pa., on U. S. 30, I noted the excellent shoulder and ditch work, as shown by the accompanying picture, being done by the state highway department. The work was done mostly on curves and increased their sight distance wonderfully. The stones are laid in soil but not grouted. Relief labor was being used but the resulting job is excellent.

Shoulder and Ditch Work on U. S. 30

• •

¶ In buying a cut-back asphalt or fluid tar for road purposes, what do you want to know about it before you place an order? What information do you want about a particular asphalt or tar before you decide to buy it. Do you purchase on a price basis alone when the materials of different companies meet the specification you decide to use? Please drop me a line answering these questions.

• •

¶ In the case of East vs. West in the matter of good highways, yes and streets, too, I vote for the West.

• •

¶ Let's eliminate the pest on the highways known as the "Line Rider." This particular type of obnoxious nuisance straddles, or drives on, the traffic line separating lanes. I suggest that State Highway Patrol Officers take these pests in hand.

• •

¶ While there may be differences of opinion among leading engineers on the particular equipment to use to give smooth riding surfaces for black top maintenance work, there is agreement on basic method. One engineer may recommend a long base broom drag as the last operation, while another may recommend a hone. Both types of equipment produce a smooth riding surface when consistently used.

• •

¶ Little does the public know about design of road surfacings. They are interested, primarily, even wholly, in a smooth riding surface. If they can drive at fifty miles an hour without jolting or bumping, to them the road is a good road.

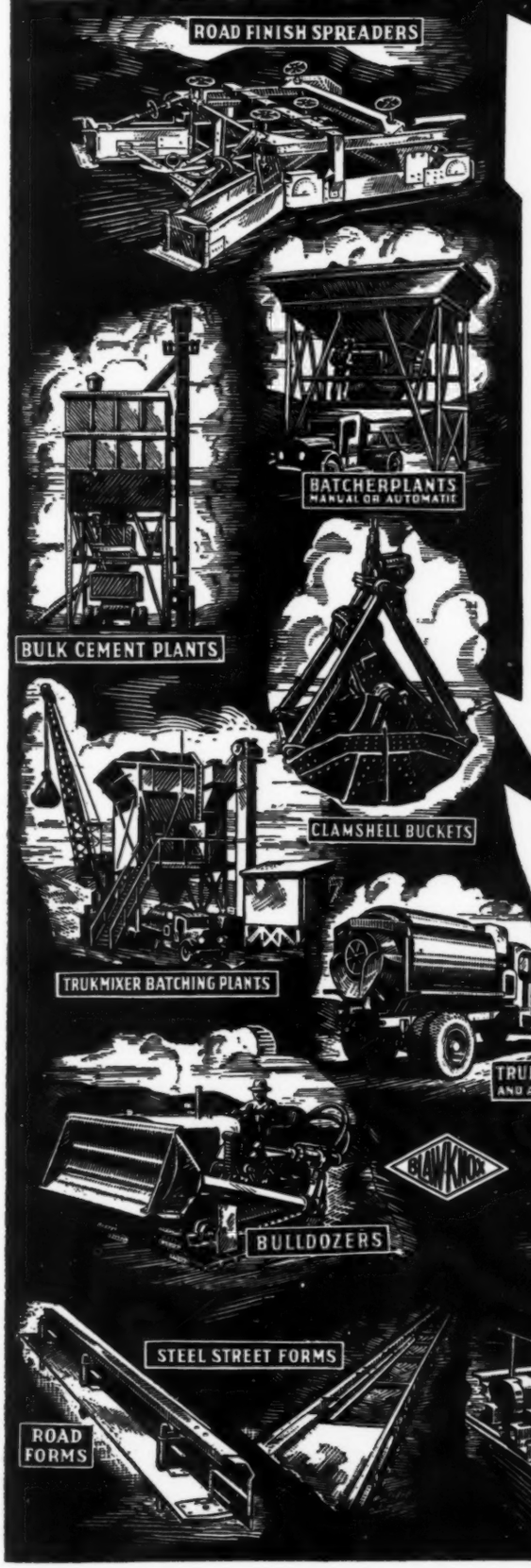
• •

¶ Judging from the numerous types of joints used in concrete paving work and the cracks at joints and corners there is apparently much yet to be learned about joints.

• • •

¶ Why don't *all* asphalt and tar manufacturers set up a research agency for studying bitumens as used in road work?

BLAW-KNOX



Points the way to profitable road building

The use of Blaw-Knox Road Building Equipment provides the short cuts to economy which are essential to profits in today's scheme for building roads.

How will this equipment fit into your road building operations?

Just ask Blaw-Knox!

BLAW-KNOX COMPANY
2001 Farmers Bank Building
PITTSBURGH, PA.
Offices and Representatives in Principal Cities

BLAW-KNOX
LEADERSHIP
CONSTRUCTION EQUIPMENT
also includes:—
STEEL FORMS FOR GENERAL CONCRETE CONSTRUCTION
CEMENTANKS
TAMPING ROLLERS
CENTRAL MIXING PLANTS
CONCRETE BUCKETS
STEEL BUILDINGS
STEEL GRATING

EDITORIAL

Ferreting Out a Sale

ENGINEERS and contractors have the right to expect a job analysis for plant setup from salesmen, dealers or distributors who are interested in selling them a piece of new equipment. Every salesman has his own way to sell construction equipment. In general, however, their method may be classified under the head of selling by specification and comparison. Before a contractor or engineer buys a piece of new equipment he pretty well satisfies himself that he needs the unit. It may be that the unit he thinks he needs is not the economic unit for the job. The feeling of need that the prospective buyer harbors is a mental condition and is independent of any measuring stick. By removing the feeling of need from the indeterminate field of desire to the determinate field of economic justification, the problem of selling a new unit of construction equipment becomes one of economic analysis of plant setup for the job on which the unit is expected to be used.

And as stated before, contractors and engineers who have construction work to do should expect job analysis service from equipment salesmen or distributors who are trying to sell them equipment. The plan presented or prepared for the plant setup should be complete enough in details of output and performance as to leave no doubt that it is the most economical. It is, really, a duty of the salesman to render this engineering service.

It is well known that construction units are employed efficiently on many jobs and likewise, too well known that they are also employed inefficiently. An operator may be getting the best possible efficiency out of his particular unit considering the conditions under which he is operating because the overall efficiency of the job may be low. This is the fault of management, not the fault of the individual equipment operator. On the other hand, the overall efficiency of the job may be the maximum possible with the equipment at hand, yet the cost per unit of output may be higher than necessary, considering other as well as newer types of equipment that are available. Here is where the salesman, dealer or distributor must function. This is the place he must render the service of presenting a plant setup plan indicating the most economical method of operation. Such service necessarily entails working closely with the contractor or engineer. Salesmen should be conversant with the fundamentals of the economics of plant layout, of materials handling, and of equipment efficiencies, not only of their particular line but of that of others.

The distributor, dealer or salesman who is able to analyze and recommend definite plant layouts, equipment schedules, continuity of processes, and progress schedules, to the engineer or contractor, that will result in the least unit cost with the contractor's present or some other equipment is the man who will have served as is expected of him and thereby be in the best position for listing the engineer or contractor as a customer. No two jobs are alike. No two contractors have the same equipment or equipment in the same state of repair or depreciation. Therefore, for every job there is an economic lower limit of cost beyond which the contractor is unable to go. It might, however, be shown, that by changing certain pieces for new pieces, or by changing types of equipment for a particular job under consideration, a lower cost per unit of output would be obtained. The difference between these two lowest costs per unit of output may be sufficient to justify the purchase of a recommended new piece of equipment.

As an illustration of the reasoning involved herein, let me take a particular case. The data for this illustration are taken from matter published by the U. S. Bureau of Public Roads.

The rate at which a concrete paver can produce concrete depends very largely on the size of the batch, the length of time which it must be mixed, the design and condition of the mixer, and rate at which the mixer is fed. On two Wisconsin jobs, in order to fix definitely the causes for delays at the mixer, auxiliary equipment such as the cranes, butcher bins, trucks, and finishing machines were studied to determine their relation to the rate of production. The live wire distributor or salesman will have had the contractor gather these data for him or so keep his records as to be able to get the data desired when he is ready to analyze a proposed job setup.

The contractors of these two jobs each had old pavers when the projects were started. It did not take very long to show that new pavers would justify their cost and accordingly they were installed. The difference in the mixer cycles between the old paver and the new paver were found to be surprisingly large. Because of this shorter mixing cycle alone, it was possible to obtain an increase of 10 per cent or more in production by using the new pavers.

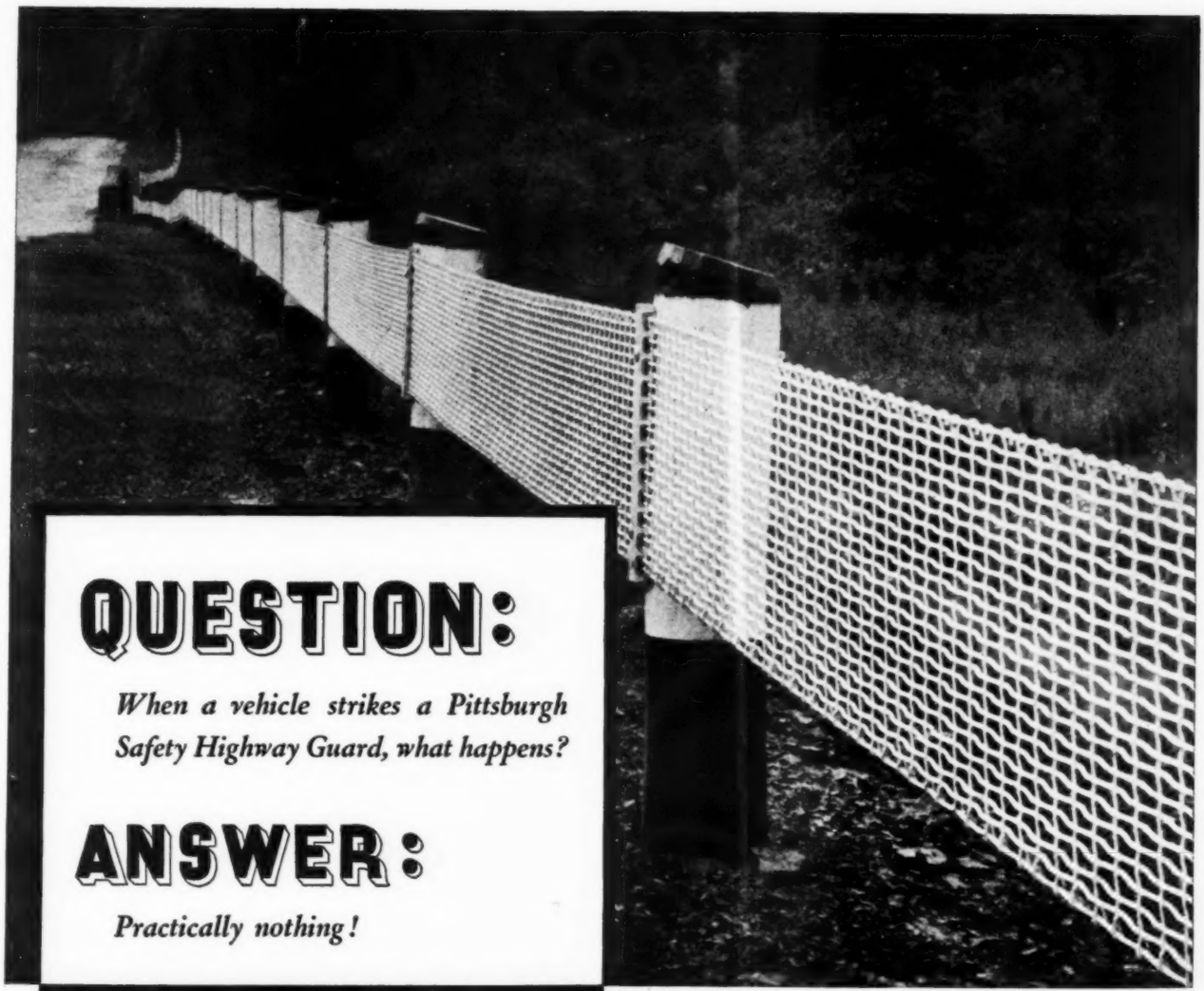
Because of the shorter mixing cycle and better mechanical condition of the new paver, its actual advantage in increasing production, and therefore in lowering cost per unit of output, was even greater than indicated above. The following table gives comparative results:

AVERAGE HOURLY RATES OF PRODUCTION ON WISCONSIN JOB 2916

Size of Batch Cu. Ft.	Square Yards Per Hour 60-second Setting of Batch Meter		Percentage Increase Over Old Paver Using 27 Cu. Ft. Batch
	Old Paver	New Paver	
27	188.1	217.2	15.5
30	218.5	257.6	36.9
33	222.5	260.0	37.3
35	.....	271.0	44.1

On this job a 50-second mixing time was allowed and 33 cu. ft. batches were mixed. It was found that the finishing machines and finishing operations could, and did, readily keep up. It was also true of the other auxiliary equipment. This combination of mixing time and size of batch did not, therefore, require more, or larger auxiliary equipment. In fact the maximum efficiency of the coordinating units was not entirely attained. A larger mixer could have been recommended and economically justified.

This same type of analysis could and should be applied to all of the individual coordinating units. Such analysis will disclose possible sales to the distributor or salesman. Problems of this nature and a discussion of the fundamentals of contract management may be found in "Economics of Construction Management," by J. L. Harrison.



QUESTION:

When a vehicle strikes a Pittsburgh Safety Highway Guard, what happens?

ANSWER:

Practically nothing!

Because:

. . . 24 semi-spring steel wires extend the entire length of the guard providing enough "give" to snub the shock of the impact.

Examination of 90 random collision points by the Pittsburgh Testing Laboratory revealed ALL horizontal wires intact. Displaced vertical wires were positioned quickly on the spot by cheap labor. *Practically nothing had happened to the guard.*

Each point of impact was examined for evidence of vehicles passing through or jumping over the guard. None was found and no instances could be traced. Beyond scratches and possibly dented fenders, *practically nothing had happened to the vehicles.*

GET THE FULL STORY

For a detailed description of the use of Pittsburgh Safety Highway Guard and a summary of the Pittsburgh Testing Laboratory's survey, write today or mail the coupon.

PITTSBURGH STEEL COMPANY

742 Union Trust Building **Pittsburgh, Pa.**

New York Chicago Detroit Memphis Houston St. Louis
Syracuse Philadelphia San Francisco Los Angeles
Charlotte, N. C.

Pittsburgh Safety HIGHWAY GUARD

Pittsburgh Steel Company,
742 Union Trust Bldg., Pittsburgh, Pa.
Gentlemen:
Please send me a summary of the Pittsburgh Testing Laboratory's report on Pittsburgh Safety Highway Guard.

Name..... Title.....

Address.....

NEW EQUIPMENT AND MATERIALS

New 10 Yard Wagon-Scraper

The Tractor Equipment Division of the Continental Roll & Steel Foundry Co., East Chicago, Ind., announce the addition of a new 10 yd. wagon-scraper to their line of tractor and road building equipment.

This 10 yd. wagon-scraper, known as Model CS10A, is the full carying type tractor scraper, identical in design and appearance to the Continental 5 and 7 yd. wagon-scrapers, and embodying the same general operating features.

It is ruggedly constructed throughout of "Dynamic" heat-treated alloy castings, alloy heat-treated shafts; the digging bucket, the patented front apron and rear dump door being

Continental's New 10-Yd. Wagon-Scraper

fabricated of special steel plate, arc welded into strong one-piece units. Overall length is 16 ft. 9 in., width 11 ft. 9½ in., height 6 ft. 9 in.

This new 10 yd. Continental, built for use with 75 h.p. and larger tractors, is especially designed for digging, loading, hauling and dumping the tough clays and gumbo soils, shales, hard pan and rocky soil as well as the loams and sandy clays, etc., and other soils commonly called "good scraper dirt."

The hydraulic power control unit furnished with this wagon-scraper consists of a new heavy duty hydraulic pump, embodying all the proven features to give a long lived, trouble free power unit; a free working control valve and rear type control lever allowing fingertip control by the tractor operator.

▼

New Plow Combines Push-Plow Blade With 42-in. Rotor

A combination rotor and blade designed to eliminate snow banks from the road and yet retain the speed and flexibility of the blade plow has been proved successful in removing drifts from western highways, according to its manufacturer, the Snow Removal Equipment Co., 557 Bryant St., San Francisco, Calif.

"Rotoblade," as the unit is known, is stated to cut a swatch 9 ft. wide, rolling the snow toward the rotor, which, whirling at 500 r.p.m., throws the snow from 40 to 60 ft. clear of the highway.

FWD Truck Equipped with a Hewitt "Rotoblade" Plow

"Rotoblade" Plow Operating on a California Highway

Several years ago, Walter Hewitt, chief mechanic, maintenance department, Rainier National Park, began experimenting with a combination rotor and blade plow. His special desire was to build a unit that would not leave shoulders on the side of the road on its first or patrol trip.

The new unit was built and maintained on a 100-h.p. FWD truck. Four years of experimental work then followed. By trial and error Hewitt finally achieved the result he desired.

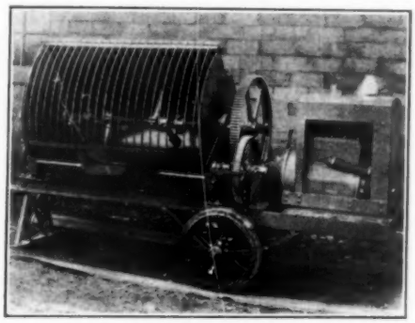
In operation the "Rotoblade" gets its power from a power take-off direct from the truck's drive shaft. The entire unit weighs less than 3000 lb. and can be attached or detached in 30 minutes. It is stated that at special speeds varying from 6 to 20 miles per hour the rotor has been successfully operated in snow varying in depth from 6 to 20 in. According to its manufacturer, "Rotoblade" is not intended for use as a road opener, neither is it claimed that it will function in snow from 6 to 8 ft. deep.

For city street snow removal the chute is placed over the rotor to control the discharge and load a truck driven alongside. A swath 9 ft. wide is first cut by a blade plow shoving snow away from the curb toward the middle of the street. The loaded truck follows this swath with the "Rotoblade" in the center of the street. Snow is loaded directly into the truck as it moves forward. This plan removed "windrows" formed along sidewalks and which were often not removed for several days. Sometimes picks and crowbars have been required to remove this hard-packed snow, necessitating extra expense for this labor.

▼

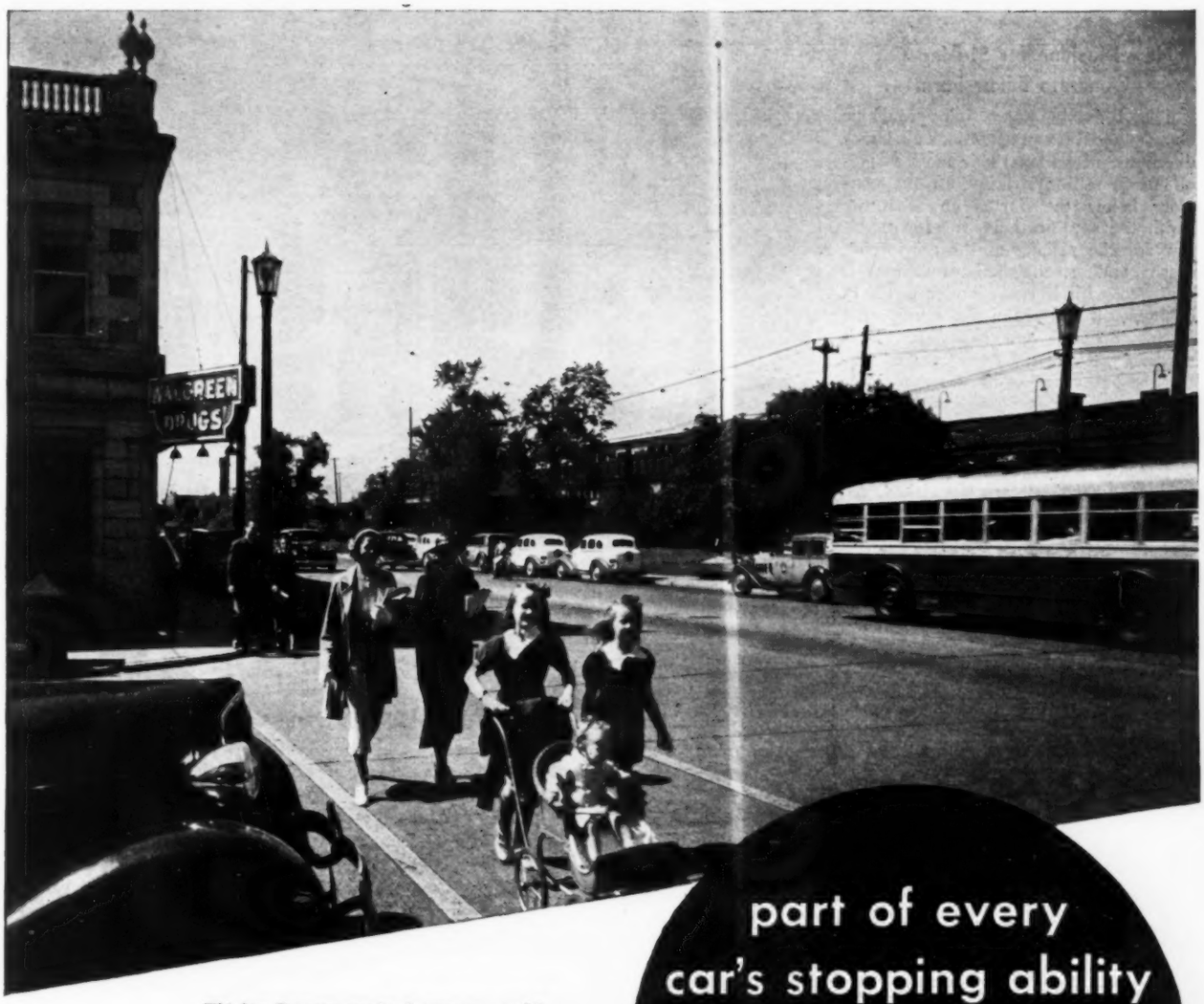
Mixer for Road Repair and Patchwork

A concrete mixer claimed to be particularly useful for road repair and patch work is illustrated below. It is a product of the Blystone Manufacturing Co., Cambridge Springs, Penn. An important feature of the mixer is its patented spiral shovel system



Blystone All-Purpose Mixer

of mixing. This consists of a series of shovels that thrust the materials to the right and catch them, returning them to the left. This action takes place 50 times in a minute. Another feature is the non-clog discharge door, which is opened and closed with a toggle-joint arrangement which is positive in action. The mixer can be moved about by two men, and it can be hauled from place to place by fastening it to an automobile. The mixer is made in these sizes: 5, 7, 11 and 14 cu. ft. per batch.



This busy Evanston crossing is concrete—and is one reason why Evanston has repeatedly won traffic safety awards for cities in its classification.

part of every
car's stopping ability
is in the road
you stop quicker on
CONCRETE

THE stoplights change, the whistle blows—and millions of cars must stop millions of times on busy city streets. No matter whether these stops are due to regular traffic interruptions or to emergencies, safety demands that they be made swiftly and surely without skidding or slipping.

When you pave with concrete, you provide traffic with the safest of all road surfaces. Its fine, gritty texture offers maximum traction under any weather conditions; reduces skidding to the absolute minimum.

Concrete roads and streets have a flat crown and even contour that make them usable over their entire width—cars don't tend to bunch up dangerously in center lanes; passing is safer. Night-time visibility is better on concrete's light gray surface, whether the illumination is from street lights or from automobile headlights.

Concrete saves money for taxpayers because it costs less than any other pavement of equal load-carrying capacity. It lasts longer. Its surface maintenance cost is far less. It saves money for motorists in reduced gas, tire and car repair bills.

PORTLAND CEMENT ASSOCIATION
Dept. A10-28, 33 West Grand Avenue, Chicago, Ill.

New Machine for Striking Off Concrete Below Forms

The Flexible Road Joint Machine Company of Warren, Ohio, has introduced the new Flex-Plane mesh strike-off machine for striking off the concrete below the forms to whatever depth the specifications call for to allow for the placing of the reinforcing mesh and steel. This machine is equipped with a two-cylinder 8 H. P. engine, also transmission unit for speeds forward and backward; it is so arranged and underslung as to permit the paver bucket to swing over the center section. It is equipped with a reciprocating strike-off blade, which can be set to various crowns of the pavement.

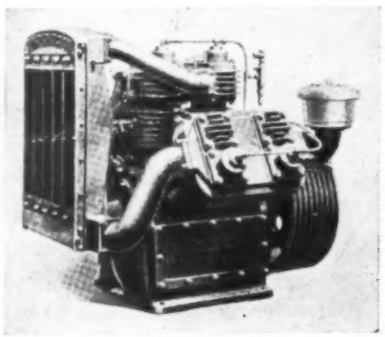
These machines are furnished for constructing pavement strips from 10 to 20 ft. wide. The approximate weight of the 10-ft. unit is 2900 lb.; the 20 ft. unit, 4100 lb.

The Flex-Plane mechanical strike-off is illustrated and described in Bulletin R-7.

"Flex-Plane" Mesh Strike-Off Machine

Vertical-Angle Three- and Six-Cylinder Air-Cooled Compressors Announced by Worthington

Worthington Pump & Machinery Corporation, Harrison, N. J., now offers its latest development in three- and six-cylinder vertical-angle two-stage compressors.



New Worthington Compressor

A line of compact, self-contained units with capacities ranging from 142 to 445 cubic feet per minute has been developed. The three-cylinder has two low-pressure cylinders set opposite each other at an agle, with a high-pressure cylinder set vertically between them. The six-cylinder unit is set up in the same manner, with two cylinders side by side in each position. The units may be had with Worthington Multi-V-Drive, direct-connected to the motor through a flexible coupling, or with the motor mounted directly on the end of the crankshaft. The compactness of this unit combined with the variety of drives available makes it easily adapted for installation.

Automotive type pistons with two compression rings, two oil rings, and full-floating wrist pins are used on all models. Articulated connecting rods permit the use of a large crank pin bearing and the same center line for all cylinders. A finned, radiator type intercooler, with a fan which draws air through the cooler and over the cylinder head, quickly removes the heat of compression. A large oil reservoir in the crankcase, force-feed lubrication, an oil cooler and an oil filter assure complete and efficient lubrication of all moving parts. The suction and discharge valves are in separate compartments, allowing removal without disturbing the pipe connections. The crankcase is fitted with large cover plates, providing speedy and easy inspection of the running gear.

A descriptive bulletin showing photographs and details of these units may be obtained from the manufacturer. Ask for L-620-B16.

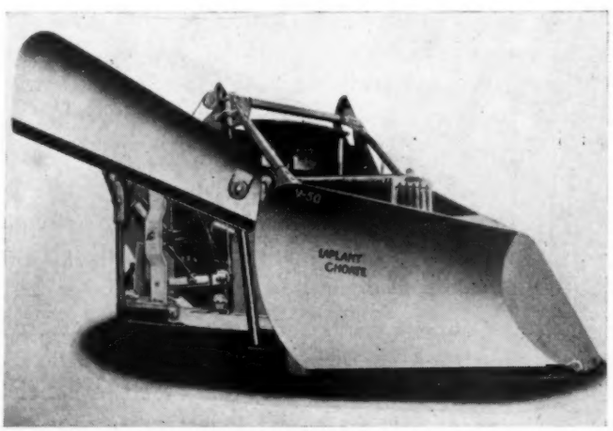
1937 Model La Plant-Choate "V" Plow

Special features and improvements found on the 1937 model, full-hydraulic La Plant-Choate snow plow are: first, down-pressure on the plow as well as lifting pressure. This down-pressure forces the plow into the hard packed snows, and prevents the plow from riding out, as was the case where plows depended upon weight entirely, for suction, in the past.

These plows are, also entirely track-mounted, without the rear cross member as in the past. This type of mounting gives the snow plow a much higher lift and prevents the tractor from high-centering on the side frame when the tracks are spun, as was often done when the plow had a frame completely surrounding the tractor.

Higher lifting and longer wings enable the plow to throw the snow farther out from the center of travel. A dividing board in front of the "V," enables the plow to use the full width of one side when pushing back side banks, and prevents spilling of materials back into the road.

Another special feature incorporated in the design of the La Plant-Choate new model plows is a tractor mounting which enables the owner to back out of a "V" type plow and drive into a roadbuilder or bulldozer, thus utilizing the same hydraulic controls which were used with the plow. These plows are designed for use with a Caterpillar RD-7 tractor.



The New La Plant-Choate Plow

20-50-80 Feet and over...
PAGE AUTOMATICS OUTDIG OTHER DRAGLINE BUCKETS AT ANY DEPTH

Users Report

20% to 50% increase in yardage on all types of dragline work.

An open-pit coal miner writes:

"The AUTOMATIC bucket will dig in deep holes as long as you keep rope long enough to go deeper. We have been convinced that this bucket has increased our production at least 75%."

A gravel plant owner says:

"It comes up with a full load when working blind under 15 ft. of water."

A contractor reports:

"Since putting on the AUTOMATIC we are digging at least 50% more material."

As hundreds of AUTOMATIC owners have done—you, also can increase your dragline yardage and profits. For information on a size and weight AUTOMATIC bucket best fitted to your machine and job, see your equipment dealer or write us direct. Free bulletin "The AUTOMATIC" gladly sent on request. Address Dept. R.

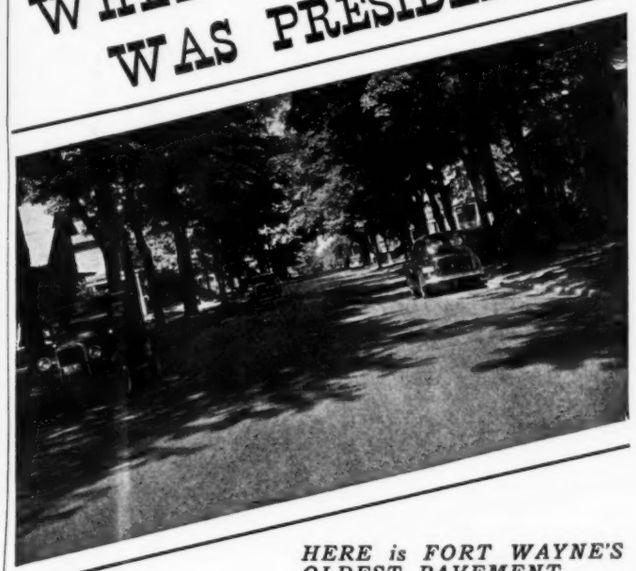
BUILT IN SIZES 3/8 to 15 CUBIC YARDS

"DIG WITH A PAGE AUTOMATIC"

PAGE ENGINEERING COMPANY
CLEARING POST OFFICE CHICAGO, ILLINOIS

This TRINIDAD Street was laid

WHEN HARRISON WAS PRESIDENT



HERE is FORT WAYNE'S OLDEST PAVEMENT . . . 47 years of service and still going strong is the record of *Trinidad Native Lake Asphalt* on Wayne Street, Fort Wayne, Ind., laid in 1889 in the horse-and-buggy days of President Benjamin Harrison.

There is only one way to judge the value of an asphalt pavement—its record of service under traffic and under various climatic conditions. You know that ductility and adhesiveness are related properties, and if the pavement is to last the bitumen must be of such a character as to stand the weather and traffic without hardening and cracking. The Fort Wayne pavement above was built for days when high speed motor traffic was unknown, unexpected, and is proof that Trinidad pavements are built to endure.

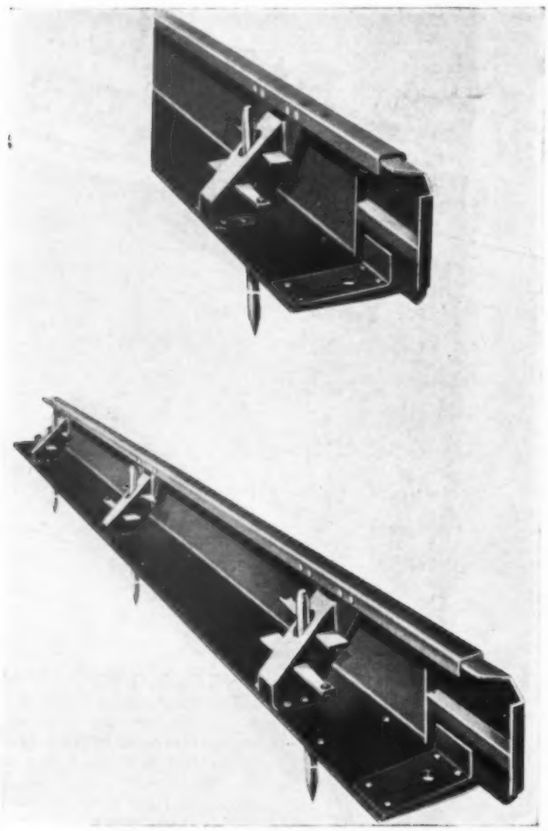
Incidentally, Trinidad Native Lake Asphalt will cover your present old concrete, brick granite or block pavements, giving you a *new* street for the price of an asphaltic top.

THE BARBER ASPHALT COMPANY
New York Philadelphia Chicago St. Louis

TRINIDAD
NATIVE LAKE
ASPHALT

New Blaw-Knox Self-Aligning Road Form

The self-aligning feature of the new Blaw-Knox Road Form is accomplished with two wedges on each of the stake pockets. The upper wedge is operated by hand until it contacts the stakes.



New Blaw-Knox Self-Aligning Road Form

This takes up the usual clearance between the wedge and the stake, eliminating movement of the form when final locking is done. The lower wedge is then driven up with a hammer for final locking. This prevents movement of the form from line or grade and permits quick and accurate form setting even though the stakes be bent or driven crooked.

▼

New Drag Line Bucket Chain

A new design of drag line bucket chain has been announced by the American Manganese Steel Co., 406 East 14th St., Chicago Heights, Ill. Patent has been applied for.

The manufacturer claims ten distinctive design features:

Increased strength over previous Amsco chain.

Full line instead of point bearing between links.

Additional metal on sides of links where abrasive wear comes.

Lighter weight than comparable cast chains.

Considerably lighter weight than previous Amsco chain.

Tie bar across link to prevent snarling and kinking.

Equalized metal sections insuring perfect heat-treatment in manufacture and consequent better physical properties.

Clean lines making for clean castings.

Distinctive design.

Made of heat-treated austenitic manganese steel which combines strength, toughness, and wear resistance.

New Material Spreader

A new material spreader has been announced recently by the All-Purpose Spreader Co., Elyria, O., which is claimed to be applicable to the spreading of dust, screenings, pea gravel, chips, dust-laying chemicals on new macadam and black top construction and maintenance, and on spreading cinders, sand, salt, or chemicals on anti-skid work.

The device is attached to the back of a dump truck, materials being dumped through an opening in the end gate into a large hopper. The material is then discharged through a manually controlled measuring gate in the hopper onto a whirling or revolving disc which casts the material onto the ground in a circular or umbrella-shaped shower of material.

The power for whirling the disc comes from the traction of the four industrial-type pneumatic balloon tires on which the spreader rests. These tires are mounted on wheels fastened to a horizontal axle which passes through an automotive type differential, which in turn drives a vertical axle which is connected to the disc. Thus as the unit is traveled over the road the traction of the tires causes the disc to revolve in proportion to the speed of the unit. All propelling gears run in lubricant.

New Material Spreader in Action

Due to the differential action, it is claimed that the spreader is equally efficient in either forward or backward directions. It is also claimed that this action maintains the uniform disc speed on curves to permit the same coverage per square yard on curves as on straightaways.

The light weight of the spreader, resting on four balloon tires, is stated to reduce ground pressures to a point which permits spreading without disturbing keyed subgrades. The differential action eliminates skidding, binding or sliding of the wheels over the subgrade.

A wide range of width of spread is claimed, varying from 3 ft. on shoulder work to 30 ft. on anti-skid work. Great flexibility is also given on the permissible coverage per square yard, which, it is stated, can be varied from 0 to 85 lb. of material per square yard.

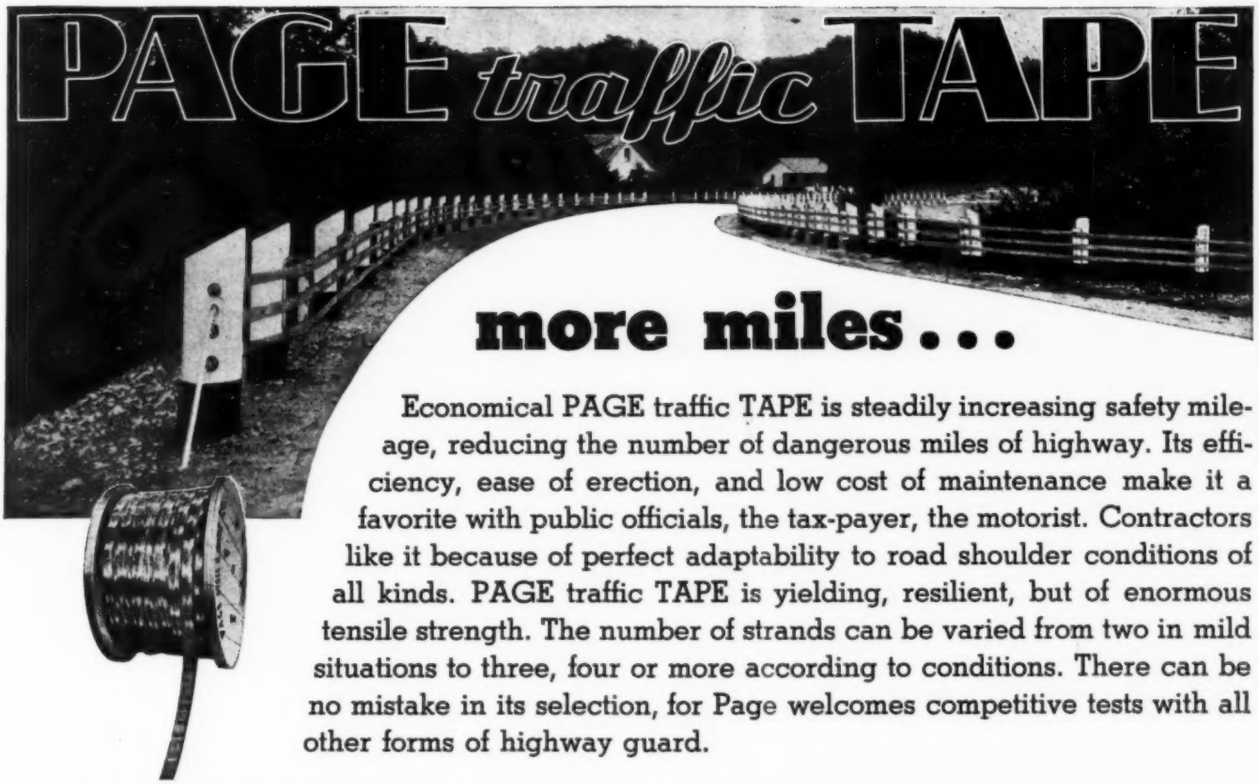
▼

New Unit for Cleaning Heavy Equipment

A new heavy-duty cleaning unit has been announced by the Homestead Valve Manufacturing Co., Coraopolis, Pa. The manufacturers recommended it for such difficult cleaning jobs as the removal of all dirt and grease accumulations from tractors—without disassembly; the cleaning of motors and underpinning of trucks; the cleaning of highway safety equipment, such as guard rails, center lines, bridge abutments, etc., and the other laborious cleaning in this field.

In use, Model E utilizes the combined advantage for cleaning of a mixture of vapor, hot water, soap or a selected chemical,

PAGE traffic TAPE



more miles...

Economical PAGE traffic TAPE is steadily increasing safety mileage, reducing the number of dangerous miles of highway. Its efficiency, ease of erection, and low cost of maintenance make it a favorite with public officials, the tax-payer, the motorist. Contractors like it because of perfect adaptability to road shoulder conditions of all kinds. PAGE traffic TAPE is yielding, resilient, but of enormous tensile strength. The number of strands can be varied from two in mild situations to three, four or more according to conditions. There can be no mistake in its selection, for Page welcomes competitive tests with all other forms of highway guard.

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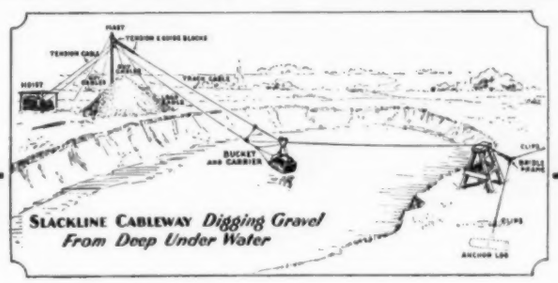

SLACKLINE CABLEWAY *Digging Gravel From Deep Under Water*

Long Range Excavators

Crescent Drag Scrapers and Sauerman Slackline Cableways are low-cost excavators designed to dig and move a maximum yardage of earth with a minimum expenditure of man-power and motive power.

If you are interested in studying new ways of working gravel pits, grading highways, excavating canals, cleaning out reservoirs, and other earth-moving work, send for Catalog No. 17.

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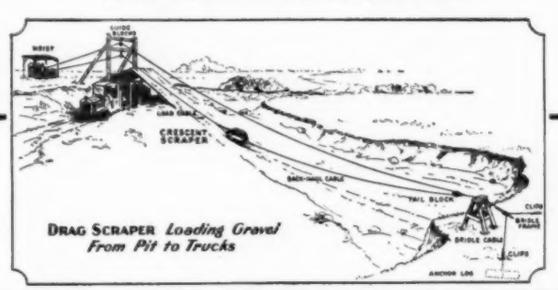


DRAG SCRAPER *Loading Gravel From Pit to Trucks*

Model E Hypressure Jenny

and pressure. The unit, being fully contained, carries its own fuel tank, water and solution tanks, oil burner, and vapor generator.

Simplicity of operation is an important feature of the equipment. It does not require the services of a licensed engineer or a skilled mechanic. All that is needed to place it in operation is a water line to the water tank and an electric connection. The whole unit is set in motion by an electric switch. Water and solution are pumped from their respective tanks and automatically mixed to predetermine proportion en route to the generator coils, where the solution is heated. By turning a valve on the cleaning gun, a vapor spray emerges from its nozzle with great velocity. This velocity, combined with the reaction of the heated cleaning solution, breaks up the accumulations of grease, dirt, or whatever material is being removed. The flushing action of the spray washes away the loosened accumulation.

A new feature of Model EH (which is identical in size and appearance to E) is that two operators can work simultaneously from the one machine. This has been made possible by the addition of the second cleaning gun connection and by increasing the unit's pressure and general capacity.

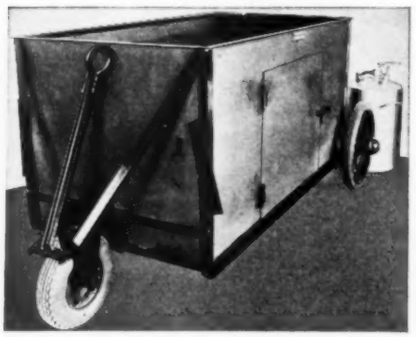
New Tool for Breaking Boulders

A new tool developed to simplify the breaking of large rocks and boulders, eliminating the use of explosives and the plug and feather method, has been placed on the market by the Atlantic Steel Co., 1775 Broadway, New York. The breaker is specially heat-treated and is made from Atsco steel. It fits the standard paving breakers. It is made in several sizes with 1⅛-in. and 1¼-in. hexagon shanks. In breaking boulders or large rocks a hole is drilled about 12 in. deep. The tool is then placed in the paving breaker and inserted in the drill hole. It is stated that after a short pounding the rock will readily split.

Boulders Broken with the Breaker. The Tool Is Shown in the Middle of Each Rock

Rock Asphalt Heaters

In use of natural rock asphalt for street and highway maintenance it is frequently advisable to heat it before laying. This is especially true in cold weather or for handling material which has been stockpiled for some time.



White Rock Asphalt Heater

Heated rock asphalt can be placed in holes or on depressed surfaces much better than cold waterial and makes a patch which stays in place. It also assumes full compaction under roller or tamper, which is not always obtained when laid cold.

While rock asphalt spreads and tamps readily in warm weather without special heating, difficulties encountered in cold weather are eliminated by heating. Thus satisfactory repairs can be made in all seasons.

In co-operation with the Kentucky Rock Asphalt Institute, a heating apparatus has been produced by the White Manufacturing Co. of Elkhart, Ind. This consists of an all-steel box or heating chamber, mounted on wheels or plain steel skids. Near the top of the box is a heavy wire mesh screen on which the rock asphalt is dumped or loaded. Immediately under the screen is an inverted V heat deflector which prevents direct flame contact with the bituminous material.

As the material becomes warm and dry, it drops through the screen into a lower compartment. It may be necessary to stir it to break lumps or to jar the screen so that material will fall through. A large hinged door permits the warm material to be shoveled out. In cold weather the asphalt can be kept in the box, if desired, during patching work and heat retained by throwing a canvas cover over the top of the unit.

Heat is furnished by a White self-generating burner held in a bracket at one end. Fuel is supplied from a 15 or 20 gallon kerosene tank.

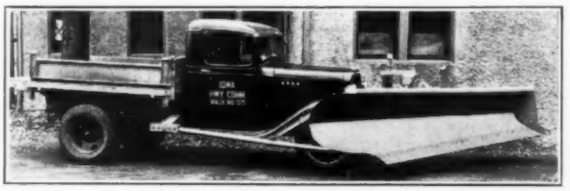
New Cement Unloader and Conveyor

The new improved automatic remote-control unloader of the Fuller Co., Catasauqua, Pa., for unloading and conveying portland cement and other dry pulverized materials differs considerably from those previously manufactured by this company, in that many improvements and refinements have been incorporated, resulting in greater reliability, flexibility and efficiency.

Capacities and pumping distances are greatly increased, principally because the screw-shaft motor is employed solely for pumping. The maximum motor power is continuously employed with respect to volume of material and the distance of conveying. Delivery of material is maintained at a constant maximum rate by permitting the operator to force the operation, as the necessity for rearward movement, in anticipation of slides, and stoppages due to overloads are eliminated by the provision of positive means to prevent such overloads. It is stated the machine will function efficiently even though it may be buried entirely under a slide of material.

Operating under remote control allows the operator to advance the machine into the stored material and maintain it under full load. It also permits him to leave the machine while it is in operation so that he may sweep or otherwise clean the floor of the residue of material. Also it permits him to operate from a

PARSONS' SNOW PLOWS . . .



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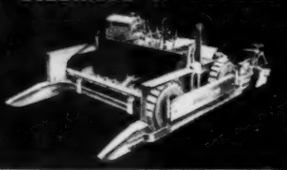

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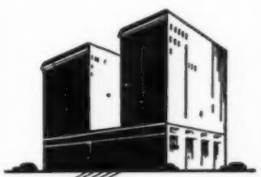

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Automatic Remote-Control Unloader Withdrawing Cement from a Bin. Note Operator with Automatic Hand-Control Switch

safe distance when recovering cement from piles in a storage warehouse and to prevent damage to the apparatus due to careless operation.

▼

WITH THE MANUFACTURERS

"Caterpillar" Appoints Western Advertising Representative

Prompted by the belief that the area west of the Rocky Mountains presents sales and advertising problems which can be handled more effectively by one who is located on the ground, and therefore able to keep in closer touch with changing conditions, the Caterpillar Tractor Co. of Peoria, Ill., has appointed G. W. Monfort as western representative of its advertising department. Mr. Monfort was employed by "Caterpillar" in the capacity of assistant news editor several years ago. Following this position he operated an advertising agency under his own name in Berkeley, Calif., and more recently he was a member of the sales promotion department of Union Oil Co., which position he left to go with "Caterpillar." Mr. Monfort will make his headquarters at the western sales office of the company in San Leandro, Calif.

▼

Wheeler Appointed Sales Manager

Richard A. Wheeler, for the past 14 years associated with tractors and tractor equipment, and more recently in charge of sales for the Continental Roll & Steel Foundry Co., was recently appointed sales manager of the Tractor Equipment Division of the Emsco Derrick & Equipment Co. Following the recent purchase of the Hutchins Winch Co. by Emsco, the Tractor Division sales office was transferred from Los Angeles to Chicago, where Mr. Wheeler will make his headquarters at 332 S. Michigan Ave.

The Emsco Derrick & Equipment Co. now has four manufacturing plants located at strategic points about the country for the manufacture of cable and hydraulically operated bulldozers, trail and angle builders, rippers, carry-all scrapers, and other tractor operated construction machinery.

▼

Higgins Now Advertising Manager for FWD

Francis M. Higgins, market research analyst of the Four Wheel Drive Auto Co., has been appointed manager of advertising to succeed W. M. Hanson, resigned. With the FWD company since 1926, Higgins has filled various capacities in the sales and advertising departments. He is the author of a digest of road laws and highway truck regulations published by his company in 1934, and winner of national recognition for this work.

▼

New General Office Building of Jaeger Machine Co. Has Latest Features

Completely insulated construction, year 'round air conditioning, sound proofing, and the use of glass block windows, diffusing skylights and Venetian blinds for the scientific control of lighting are some of the features of the new general office building of the Jaeger Machine Co., manufacturers of construction and road machinery at Columbus, O. According to O. G. Mandt, vice president and general manager, expansion of the company's business, which in the first eight months of 1936 has more than doubled the entire volume for 1935, made necessary this move to larger and more efficiently arranged quarters. All offices have been located on one main floor, each department grouped in relation to its work with other departments. On the floor below is a 10,000 sq. ft. showroom for displaying and demonstrating the company's products: pumps, mixers, hoists, truck mixers and road machinery.

General Office, Completely Enclosed, Under Diffusing Skylight

Year 'round comfort for employees is provided by full automatic air conditioning which controls both humidity and temperature. This system filters and completely changes the air throughout the building every three minutes. Executive offices are sound proof and specially insulated. Insulating glass block walls line the north and west sides, and the completely enclosed central general office is roofed with 480 sq. ft. of special skylight. A conference room for visitors is equipped for the projection of motion pictures taken on construction and paving jobs.

The building, of fireproof cement block and stucco, with floors of reinforced concrete pan construction, occupies a landscaped site with wide approaches leading to the private entrance drive. It is stated that modern arrangement, equipment and attention to such factors as lighting and air conditioning have increased the efficiency of employees and routine operations as much as 30 per cent. The company's former office building has been converted into shops and experimental plant.

Glass Block Walls Provide Diffused Light for Draftsmen